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THE PREFACE

# THE PREFACE.

I Am far from being fond of their Practice, that affect to give pompous and promising Titles to their Books; in so much that my Friends have several times reproached me with inclining too much to the opposite Extream. But yet I am not averse from prefixing to the ensuing Paper, the Title of *Medicina Hydrostatica*; not only for the Conveniency of Citations, which are usually troublesome to make in Tracts that have long Titles;) but because too I am Invited, if not Authorized to do it, by the Example of the famous and judicious *Sanctorius*; who scrupled not to prefix the Name of *Medicina Statica*,

## The PREFACE.

to a Writing almost as Small, as 'tis Ingenious, which applies the Balance to *Some* Uses relating to the Medicinal Art, perhaps *not More*, than will be here found proposed of the same Instrument, improv'd by some Additions. And 'tis scarce to be doubted, but that in this Inquisitive Age, the Sagacity of the Curious will make, both of what he has discovered, and of what I have delivered, useful Applications, that neither He, nor I, ever thought of.

If the chief thing, I aimed at in Writing, had been to gain Applause, I would have taken a more likely way to obtain it, than by treating of a Subject, wherein few will think themselves concerned, (tho' many in reality be so, and whose Importance does not at first view appear.) And this Subject too, the Nature of it has obliged me, to treat of in such a way, that it will be almost as unpleasant to the Reader to peruse so unadorned a piece, as it was troublesome to the Author to write so  
Toilesome

## *The P R E F A C E.*

Toilsome an One. And indeed when I came to take notice of the Number of Particulars, that I had brought together into this little Book; I did my self somewhat wonder, how I came to be prevailed with to lay out so much Pains upon so uninviting a Subject. But Knowledge and Health are two such valuable things, that I durst not refuse to undergo, even a toilsome Task; whilst I was encouraged by the Hope, that was given me, that this kind of Labour may conduce somewhat to those desirable Ends; if not otherways, yet at least by exciting the more curious among Physicians, Chymists, and Others, to enlarge their Inquiries, and by helping them to remark divers things relating to Medicinal Bodies, that they are wont to overlook.

I had probably better consulted my Reputation, as well as my Ease, if, having contented my self with those few uncommon Notions, and Observations, that the rest of the  
Book

## The PREFACE.

Book was built upon; I had left the Applications made of them to particular Bodies, to the industry of Others. I shall not solicitously excuse my self, for not having bestowed more Ornaments upon the following Essay; since the Nature of the Subject and Drift of the Writer, are sufficient to justify the Plainness of my Style to the Judicious. I may have somewhat more cause to Apologize for this; That I have not cast a Treatise about a Subject wherein Mechanicks are so much imployed, into the Form of Propositions; and given it a more Mathematical Dress. But I was unwilling by that means to discourage those many, who when they meet with a Book, or Writing, wherein the Titles of *Theoreme*, *Probleme*, and other Terms of Art, are conspicuously placed, use to be frightened at them; and thinking them to be written only for Mathematical Readers, despair of understanding it; and therefore lay it aside, as not meant for the use of such, as they.

But

## *The P R E F A C E.*

But there is another thing, upon whose score, I confess, I ought to wish for indulgent Readers. For the Papers compiled into this Essay, having been written in loose Sheets, and at such distant times, that divers Accidents interven'd between them; the loss of some of those Papers, as well as others of different Natures, and my want of Health, and Leisure, obliged me to change more than Once my proposed design, and to imploy sometimes the Style of a private Letter, and sometimes again, that of a Discourse intended for the Publick; By which, means some Things, and some Expressions, that were suitable to the Design I had, when I committed them to Paper, became incongruous, when the Scope and Scheme of my Discourse were altered, especially Some parts of the Copy being out of my hands, when I should have adjusted the Others to them. But tho' these Irregularities may keep the parts of this Essay, from

## *The* P R E F A C E.

from being so coherent as they should be; yet they will not prove very prejudicial to an intelligent Reader; who, finding the Matters of Fact, and the Notions, to be true, may, notwithstanding the want of an uniform Contexture, make good use of them.

Tho' divers little *Memoirs* and other things, that occurred to me from time to time, whilst I was bringing together the following Papers, have insensibly swelled them into a Book; yet the Essay it self was in my First intention, but a large Fragment of a greater work: whereof an Account is given in the Letter to a Friend, (that is premis'd to a Paper annexed to the following Essay,) which (Letter) having been intended for a kind of Preface to the last Scheme of the whole larger work; if the Reader please to peruse it, he will there find the Rise, and Scope of this little Tract, as well as of the other parts of that designed Book; and some other things, that

## The P R E F A C E.

that may make it needless to lengthen this Preamble by any thing more than two Advertisements. Of these, *One* is, that, being reduced by divers unexpected, and unwelcome Accidents to forego my first design, and give only two or three *Specimens* of what was intended, and more than begun; I made choice of the Title of the Chymical Changes of Bodies by Coloration, as a Sample of the Chymical part of the Treatise; and I pitch upon the Subject of this present Essay, as a *Specimen* of the Mechanical part of the same Treatise; The *other* Advertisement, is, that the Reader need not be startled, to find some little Variations of Specifick Gravity, among some of the *Memoirs* laid together in this Essay, because he will in due place be told, why such things ought to be expected. And in the mean time, it may, I hope, suffice to say, that such Variations are neither new, nor easily avoidable things, in making *Hydrostatical* Experiments or others of Affinity to them. For

See the  
Chapters.

Proof

## The PREFACE.

Proof of which, to Readers, that, for want of having made Tryals themselves, may distrust what we have said, I shall produce a Couple of notable Testimonies. The first is given by so industrious and diligent a Mathematician, as *Mersennus* himself. For he candidly acknowledges, when he has occasion to mention some Tryals of the learned *Ghetaldus*, and of the accurate French Engineer *Monsieur Petit*, & of his own; that the Variety of weighing, which often happens to amount to some Grains, is but like the Variety of Astronomical Observations; which do almost always differ in some Minutes or some Seconds. To which he soon after adds an Intimation, that shews, that he expected not an exact uniformity between the Observations of *Ghetaldus*, &c. already made, and the Tryals of an Experimenter, that would examine them by making the like again.

*Varietas ponderandi, quæ sepius in quibusdam Granis contingit, similis est Varietati Astronomicarum Observationum quæ semper ferè quibusdam minutis, siue Primis, siue Secundis differant. Mersennus in Phænomenis Hydraulicis.*

To this first Testimony we shall subjoin the Second, which is, that our famous

## The P R E F A C E.

famous Experimenter, the Lord *Verulam* himself, writing of a Subject, that in several things has much Affinity with ours, confesses, that 'tis not to be doubted, but that many of the Bodies, which he has set down in his Table of their Dimensions, and Weights differ in the same *Species* or Denomination; some being heavier than others, and that therefore there is some Contingency in this Affair, so that 'tis not necessary, that the Individuals he made his Tryals with should be exact Standards of the Nature of their respective *Species*, or should, (which makes directly to my present purpose) agree altogether to a Title with Experiments of other Men.

But this scarce evitable Imperfection of *Hydrostatical* and the like Experiments does not hinder, but that by their help we may make good Estimates of the Weights, and Bulks, of very many Bodies; and among them of not a few that belong to two sorts of the three, that our Illustrious

*Hist. densit  
& Rarit. P.  
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Londinen.  
in Octavo.*

## The PREFACE.

industrious Author acknowledges to be reducible to his Way of Mensuration. And these Estimates will (if I mistake not) be found, not only preferable to those that can be made of the same Bodies by Geometrical Instruments; but (which is more considerable for the Reader) accurate enough to be very useful on a great Number and Variety of Occasions. Which last Clause, I purposely add to insinuate, that the Hydrostatical Way of Mensuration may be usefully apply'd to several Bodies and Cases, that do not at all seem to relate to the *Materia Medica*, as would appear by inserting here what is delivered about *Metrical*, and about *Exploratory Experiments and Observations*, in other Papers; if that were not too foreign to the ensuing Essay, as not belonging to the Subject, or to the Design of it.

*Medicina*

# *Medicina Hydrostatica.*

## The CONTENTS.

Chap. I. **T**hat Boles and less valued Stones may have as great Medical Vertues, as Gems. One quality only, viz: the Specifick gravity of Fossiles, discovered by this way of exploring them. That Rock-Chrystal, being the most pure and Homogeneous kind of Stone, is pitched upon as the Standard, which in weight is by computation, to clear Water of equal bulk, as two and an half to one. One Use of this way of weighing stony substances, viz. how far they partake of a Metalline Nature, or that of some other Mineral. From p. 1. to 7.

Chap.

## The Contents.

Chap. II. *The way of weighing sinking Bodies in Water. How to discover practically the proportion in weight, between the Solid and the Liquor.* From p. 7. to 21.

Chap. III. *An account of several Solid Bodies thus examin'd, viz. Lapis Hæmatites, Lapis Lazuli, and Lapis Calaminaris. A Note, That the greater or lesser weight of such bodies, does not necessarily imply greater or lesser Medical Vertues, or Noxious Qualities in them.* From p. 21. to 28.

Chap. IV. *A second use of this Hydrostatical way of Inquiry, viz. To find out, whether a Mineral Body propounded, as likely to be a stone, or of a stony Nature, be so indeed. This tryed in Coral, Pearl, Calculus humanus and Bezoar.* From p. 28 to 33.

Chap. V. *A Third Use, viz. to discover, the resemblance, or the difference between bodies of the same denomination.* From p. 33. to 35.

Chap.

## The Contents.

Chap. VI. *A Fourth Use, viz. to discern genuin Stones, whether Animal or Mineral, from Counterfeit ones.*

From p. 35. to 39.

Chap. VII. *A Fifth Use, viz. to make probable Estimates of the genuineness, or the degree of purity of several bodies, that are, or may, usefully be employed in Physick, though they be not Stones or Minerals, provided they be heavy enough to sink in Water. An Advertisement to Jewellers, and Physicians, what Gems are to be most esteemed of by either. An experiment of fusing Zaphora with Venice Glass, as also a Granate.* From p. 39. to 44.

Chap. VIII. *How to make Hydrostatical Inquiries into Liquids; for instance, Mercury.* From p. 44. to 54.

Chap. IX. *The way of weighing Hydrostatically the Pouders of sinking bodies, small sands, or the fragments of greater bodies. An Advertisement for the more exact weighing of these and other things.* From p. 54. to 61.

b

Chap.

## The Contents.

Chap. X. *The way of Examining Hydrostatically a body that will dissolve in Water, or easily mingle with it, viz. to weigh it in Oleous Liquors (in Oil of Turpentine, for instance) which will not dissolve it.* From p.61. to 67.

Chap. XI. *How to find out by the Hydrostaticks, the gravity of fluid bodies, viz. by weighing some one solid body in as many of them, as you please. E. G. Amber in the lighter sort of Liquors; a Globular Glass Hermetically sealed with Quicksilver in it, or Rock-Chrystal, in either lighter or heavier. The Uses of examining Liquors by an Hydrostatical Solid.* From p.67. to 85.

Chap. XII. *Several ways to find out the weight of Liquids in Water, and other Liquors.* From p. 85. to 93.

Chap. XIII. *Of what use this Hydrostatical Examination of Liquids one in another, may be to Physicians.*

From p. 94. to 99.

Chap.

## The Contents.

Chap. XIV. *Two Reasons why, in many Cases 'tis not necessary the Scales employed in Hydrostatical Experiments should be extraordinary good. An Objection against this Method of finding out the weight of sinking bodies in Water, from the different weight of the Water that may be made use, answered.*

From p. 99. to 105.

Chap. XV. *Hydrostratical Stereometry applied to the Materia Medica. Sect. I. How to find the weight of a Cubical Inch of Water; and how by means of this being found out, to find the dimensions of a Solid heavier in Specie than Water. Sect. II. How to measure by the same means the solid Contents of a Body lighter in Specie than water, whether it be of that sort of Floating Bodies that are of a closer texture, than easily to be invaded by water; or of That, that so abounds with pores, as to be disposed to imbibe the water too much, while the Experiment is a making. The same Experiment's to be made in Oil of Turpentine, of*

## The Contents.

*Bodies that are apt to dissolve in water.*  
From p. 105. to 130.

Chap. XVI. *Two Questions answered. The First, Whether I have proposed the best ways that can be thought of, to examine Bodies Hydrostatically? The Second, What credit may be given to the Estimates of the weight, and proportions of Bodies, obtain'd by Hydrostatical Tryals?*

From p. 130. to 143.

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# *A Previous Hydrostatical Way of Estimating ORES.*

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## THE CONTENTS.

SECT. I. **C**ontaining a fundamental Observation necessary, in order to make this previous Examen, viz. the finding out the Specifick gravity of a pure Stone (v.g. Chrystal, &c.) by the Hydrostatical way of Tryal, delivered above in the *Medicina Hydrostatica*. From p. 151. to 154.

SECT. II. A more general Use of the aforesaid Observation, viz. to find out, whether a Fossile have much, or little, or nothing, of a Metalline nature in it, by comparing its weight this way, with That of a pure Stone. Three Fossiles thus

## The Contents.

*thus examined, viz. the Magnet, Emeri and Lapis Hæmatites.*

From p. 154. to 159.

Sect. III. and IV. *Five Remarks to illustrate the former Observation, and make it more distinct.*

From p. 159. to 167.

Sect. V. *A more particular notice taken of Marchasites, which by their shining streaks or other glistening parts, and their ponderousness, are apt to delude the Unskilful.*

From p. 167. to 172.

Sect. VI. *An Advertisement to Examiners of ORES, concerning Flux-powders.*

From p. 173. to 175.

Sect. VII. and VIII. *Some Observations about Native Gold, and the Hydrostatical Examen of Gold and its Ore.*

From p. 175. to 185.

Sect. IX. *The Hydrostatical way of exploring Sand-Gold.*

From p. 185. to 189.

Sect. X. *Two or Three Chymical ways of Examining Sand-Gold.*

From p. 189. to 194.

Sect. XI. *An Advice to those who are given to the search of Mines,*

## The Contents.

*Mines, totake notice of any Unknown or Unommon Fossiles, they meet with; and to Examine them Hydrostatically: How to examine Ores, or Wombs, of Metals, which may be found disguis'd in the form of Earth or Mud, in an Hydrostatical Bucket. From p.194. to 200.*

*Se&t. XII. That this last way of examen may be of use in divers Cases. p.201.202*

*Se&t. XIII. The most profitable use of the Hydrostatical Bucket, is, to use it in weighing variety of colour'd Sands and Gravels. From p.202. to 207.*

*Se&t. XIV. That there is such a thing as Volatile Gold; And that corpuseles of a Golden Nature may be in Fossiles, wherein they have not been suspected.*

*From p. 207. to 209.*

*Se&t. XV. An advice to those who will apply the Hydrostaticks to Fossiles, that they procure Samples of Ores of the same Species out of different Mines; and find out what proportion of Metal they contain. From p. 209. to 215.*

*An Advertisement concerning the Table annexed. p. 216. 217.*

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## ERRATA.

**P**Age 189. l. 3. r. Tryal of such  
Wares. l. 4. dele, such Wares.  
p. 193. l. 3. r. or both. p. 195. l. 10.  
r. poise. p. 199. l. 4. dele, And. p.  
205. l. 1. r. But therefore. p. 207.  
l. 3. r. the Operation.

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ter, which hardened afterwards into  
 a Gem. The same Reasoners and  
 Reflections, that led me to the Opin-

## Medicina Hydrostatica:

think it also very probable, that di-  
 vers Boles, Clays, and other Earths,  
 and, much more, that several Minerals;

# ESSAY

my Substances, that, by reason of their  
 Rigsels or Opacity, or perhaps un-  
 pleasant Colours have been judged un-  
 worthy to be number'd among Gems.

## CHAP. I.

**I** have, in a former Tract, endea-  
 your'd (and, as I am told in Print,  
 and otherwise, not altogether  
 unsuccessfully) to make it proba-  
 ble, that divers, if not most, of the  
 real Virtues (for many fabulous Ones  
 have been ascrib'd to them) of Gems  
 or precious Stones, may in great  
 part proceed from the Qualities of Me-  
 talline and Mineral Substances. That,  
 whilst the Matter was either fluid  
 or soft, were (more or less plentiful-  
 ly) incorporated with the stony Mat-

B

ter,

## *Medicina Hydrostatica:*

ter, which hardned afterwards into a Gem. The same *Phænomena* and Reflections, that led me to the Opinion newly recited, induced me to think it also very probable, that divers Boles, Claves, and other Earths, and, much more, that several Minerals; which, tho' not looked upon as Metalline Oars, and several Stones or stony Substances, that, by reason of their Bigness or Opacity, or perhaps unpleasant Colours, have been judged unworthy to be numbred among Gems or precious Stones, may yet be indowed with considerable Medical Virtues; & perhaps with greater than the finer Gems themselves, because in these despised Stones and Minerals, there is often found a greater store of Metallick and Mineral parts, which, while they were in *solutis Principiis*, as Chymists speak, might with ease plentifully insinuate themselves into these more open Bodies, where being settled they were not lockt up so fast and strongly, as in the nobler Gems; such as Diamonds, Rubies, Saphirs,

## An ESSAY.

3

Saphirs, &c. which are of so Compact, and as 'twere Glass-like, a Nature, that divers Corrosive Liquors, and *Aqua Fortis* it self, are unable to penetrate and dissolve them; tho', as hereafter will appear, these inferior Medical Stones, and other Minerals, may be opened by the like *Menstruums*.

Upon these Grounds, I thought it might be a thing of use to Physicians, as well as to divers Mineralists and Mine-workers; if I imparted to them a Way of Exploring many Fossils, that I do not remember I had met with, either among Physicians or Chymists: And tho' this Way of Exploration pretends not to discover directly more than one Quality of the Body examined by it; yet that Quality, being its specifick Gravity, is so radical and considerable a one, that it may lead a Sagacious Enquirer further than at first sight one would think.

I considered then, that the most pure and homogeneous kind of Stones

\*Tinctures

we know of, and that seems the freest from all adventitious Mixtures, and even \*TR's. is Rock-Chrystal: And therefore I pitched upon This, as the Standard I would imploy, to make Estimates of the greater or lesser recess from Simplicity or Homogeneity of the Stones, or other Stone-like Substances, whose specifick Gravity I should examine.

We took then some Pieces of native Chrystal, clear and colourless, and having carefully weighed them first in the Air, and then in Water, we found, by Computation, that pure Chrystal was to clear Water of the same Bulk, as Two and an half, or thereabouts, are to One: So that, to clear the Matter by an Instance, if we suppose an hollow Cube, of Brass or other Metal, to be filled as carefully as may be, (for the upper Surface will scarce be exactly Level) with 3j. of Water, and if afterwards the Cavity of the empty'd Vessel be exactly filled with a Cubical piece of Rock Chrystal; this Stone will weigh

weigh'd, and about an half. Some of my Tryals indeed, made with tender Ballances, represented the Proportion of these two Bodies, with some petty Variation. But besides, that 'tis not improbable, that differing pieces of Rock Chrystal it self, tho' of equal Bulk, may not be precisely equal in Ponderosity; besides this, I say, the Variation I found from the newly assigned Proportion was so small, that having just intimated, that for the most part it rather favoured a little the specifick Gravity of the Chrystal, than fell short of it; we may neglect it without any prejudice, worth taking notice of, to the Use that is to be made of this Proportion in this Paper. And for as much as there may be some Scruple, tho' groundless, made about the Origin and Nature of Chrystal: I shall add, by way of Confirmation of what has been delivered, that I procured some strong Icicles, that had been fasten'd to Vaults, &c. as Bodies that would be acknowledged to

be true Stones, and yet to have been in a Liquid Form ; and having Hydrostatically examined these Concretions, the specifick Gravity, tho' not exactly the same in all, appeared to be little differing from that of Chrystal ; the solid Body exceeding the Weight of the fluid water, it Was Weigh'd in, about two times and an half, (a little more or less.)

Use I.

To apply this Fundamental Observation to the Uses designed in it, when I had a mind to make a probable Discovery, (for by this Way I pretend to no more) whether in a Stone, or Stone-like Body propounded, the merely stony Matter were more or less commixt with some adventitious Substance of a Metalline Nature, or that of some other Mineral more ponderous than Chrystal, I carefully weighed it : First in the Air, and then in the Water, according to the Method formerly declared, and if by Virtue of its specifick Gravity, its Proportion to Water of the same Bulk, exceeded the Proportion of five

to two (which to avoid Fractions, may be commodiously substituted to that often already mentioned of  $2\frac{1}{2}$  to one) I concluded it probable, that the Concretion had in it a Portion of adventitious Matter, heavier *in Specie* than Chrystal or mere Stone, by how much more or less the solid Body exceeded the Weight of Water equal to it in Bulk, by so much greater or lesser a Portion of Heterogeneous Matter was guest to be commixed with the stony in the propounded Concrete. This may be illustrated, as well as proved, by the Examples that should presently follow, but that it will be fit, before I descend to Particulars, to premise a Paper that concerns the whole Design of this Tract,

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C H A P. II.

**T**H<sup>O'</sup> the Way of weighing Solids in Water hath been deli-

vered by the ingenious *Martinus Ghe-*  
*raldus*, and, but of him, by some few  
 other Authors; and tho' therefore  
 I might excusably dispense my self  
 from delivering it distinctly: Yet  
 since their Books are scarce, and the  
 knowledge of this Way is almost  
 every where supposed in these Pa-  
 pers, I hold it very fit, that it should  
 once be proposed in this Tract, not  
 only for that Reason, but for Two  
 others. One, that a dextrous way of  
 finding out the Weight of Bodies in  
 Liquors, may be of far more use  
 than Men seem to be yet aware of,  
 being capable of being made, by a  
 little Variation and Improvement, of  
 good use to Naturalists, and even to  
 Chymists: And the Other, that per-  
 haps you will find cause to think,  
 that Experience and Reflections on it  
 may have furnisht me with some few  
 Expedients and Cautions for the bet-  
 ter Practice of this Art, and for the  
 avoiding of some Errors, that may  
 be very easily, and perhaps have been,  
 run into, for want of the Cautions  
 here given,

The

## AN ESSAY.

### *The Way of weighing sinking Bodies in Water.*

The Solid Body, given to be examined, is to be ty'd about with an Horse-hair of a competent length, which Hair at its other end is to be fastened to one of the Scales of a tender and exactly equilibrated Ballance, so that, the proposed Body, being exactly weighed in the Air, and then immerfed in a Glafs or other fit Vessel, almost full of fair Water, may hang freely in that Liquor, being on every side encompassed by it. This done, you must put into the opposite Scale as many Weights, as serve to bring the Body hanging in the Water, to an exact *Æquilibrium* with the Counterpoize, and consequently the Beam of the Ballance to an Horizontal Scituation. Then take out the Weights newly employed, which give you the Weight of the Body in the Water, and deducting it from the Weight formerly taken of  
the

the same Body in the Air, and by the remainder, which will be the difference of these two, divide the whole Weight of the given Body in the Air, and the Quotient (whether consisting of whole Numbers, or a Fraction, or both) will shew the Proportion, in Specifick Gravity, between the examined Solid, and as much Water as is just equal to it in Bulk. To make this more easily intelligible by an Example; We took a fine piece of white Marble, (that Stone seeming the most pure, and most free from Mineral Tinctures of any common opacous Stones) this being put into a good Ballance, whose Scales were well equilibrated, was found to weigh in the Air,  $\text{ʒij } \text{ʒiij } \text{ʒi}$ . Grains  $\text{ix}$ . which, for Conveniency of Supputation, we reduce to 1169 Grains, then an Horse-hair was ty'd about this piece of Marble, and the other end of the same Hair was fastened to one of the Scales, under which, at a convenient distance, was plac'd a somewhat deep Glass, almost full

full of fair Water, in this Liquor the Stone was made to hang freely, beneath the Surface, and in the opposite Scale, there were put Weights enough to bring it to an *Equilibrium* with the other, these Weights were found, being reduced to the former Denomination, to amount to 738 Grains, which gave us the Weight of the Marble in Water, (which was much less Weight than the former, because the Stone was partly sustained by the Water) this being subtracted from the Weight of the same Stone in the Air, there remained 431 Grains, which gave us the Weight of as much as was equal to the Stone in Bulk. By this remainder the Weight of the Marble in the Air, *viz.* 1169 being divided, the Quotient was found to be  $2 \frac{2}{3}$ , or near enough  $\frac{7}{3}$  for the Proportion in specifick Gravity of White Marble to water. The Demonstration of this Practice is founded on what I have elsewhere given, and it may, in another way, be found in some of the Commentators on

*Hydrostatical  
Paradoxes.*

*Archi-*

*Archimedes, de Inſidentibus ſubtiliter.*

For underſtanding of the Summarry Direction newly given, it may be uſeful to ſubjoyn the following Notes : Firſt, tis manifeſt by the Nature of the thing, that the Body, propoſed to be weighed, ought to be heavy enough to ſink in Water, ſince otherwiſe its Weight in that Liquor being none at all, cannot be ſignificantly deducted from its Weight in the Air; but if there be occaſion to Weigh in Water a Body lighter in Specie than it, as Bees-wax, a piece of Firr-wood, &c. It may be done, tho' not without ſome trouble, by joyning to it a Body, heavy enough to make the Wax ſink with it, but this Caſe belongs not to this place.

2. An Horſe-hair is made choiſe of, for Hydroſtatical Operations, becauſe its ſaid to be Equiponderant to ſo much Water; and tho' I have not found that to be ſtrictly true, yet an Horſe hair is fitter to be employed in theſe Tryals, than any other String, I know of; and its ſpecifick Weight uſually

usually differs so little from That of Water, that the Difference may be safely enough neglected; and if the Solid proposed be too heavy to be sustained by a single Horse-hair, one may twist two, (or, if need be) more of them, to make the string strong enough to sustain the Solid.

3. I shall add, that I have met with Bodies, about which, by Reason of their Roundness, as in Bullets, or of some other inconvenient Figure, we could not well fasten an Hair, or other string, wherewith to tie it to the Ballance. Now, on such occasions, I caused some Hairs to be so contex'd, as to make a kind of a little Hoop-net, whose Meshes were not great enough to let the Body slip through them. In this small Vessel, whether you call it a Net or a Basket, which was ty'd by an Horse-hair (single or twisted) to one of the Scales, we put the solid Body to be weighed, and proceeded in the Operation, as if the Body were tyed but with a string.

4. But

4. But here it must be carefully noted once for all, that whensoever any Hydrostatical Tryal is made with an Horse-hair ; there must be put into the Scale that holds the Counterpoize, as much of the same Hair, as can be guess to be of the same Weight with that part of the string that sustains the Body in the Water, which appears to be above the Surface of the Water ; for this Liquor takes off the Weight only of as much of the Hair as is immers'd in it, so that the unimmers'd part of the string adds to the Weight of the Solid hanging in Water ; and therefore, ought to be compensated by an equal Weight put into the opposite Scale.

5. When I kept a Ballance, only or chiefly, for Hydrostatical Tryals ; I found it expedient, on divers occasions, to take off one of the Scales with the strings belonging to it, and substitute in its room a piece of Lead, or other Metal of a Conical, or some other convenient, shape, exactly Equiponderant to the opposite Scale, and

and at the same end of the string, to fasten one end of the Horse-hair that tyed the Body to be weighed in Water. And sometimes also, when I did not take off one of the Scales, I caused it to be perforated in the middle, (yet, without lessening its Weight) that so the Body, to be immerst, might hang very Perpendicularly from the midst of the Scale. The Motives, that induced me to these Practices, cannot be so well set down in few words; and therefore shall be now left unmentioned, especially because the Practices themselves, tho' on some occasions convenient, are not necessary.

6. There remain yet a couple of Remarks, which must less than any be pretermitted, if Men would avoid some Errors, that are but too often slipt into, by the Makers of Hydrostatical Tryals. We are then (First,) to take notice, that the Body, to be examined, hang freely in the Water, so that no part of it any where touch the bottom or the sides of the Vessel,

or

or reach above the upper Surface of the Water contained in it; for, if any of these Circumstances be not taken care of, (as it happens, when we are not heedful enough) the true Weight of the Solid is somewhat altered; and if any Corner, or other part of the Body, (and the like may be said of the Horse-hair, 'tis tyed with) tho' but a small one, appear above the Surface of the Water: That extant Portion, being not at all sustained by the Liquor, adds (more or less) to the Weight, that the immerst Body should have. Care also must be had, that, as nothing but the Water do touch the hanging Body, so, no part of the Water may touch the Scale whence it hangs. I have several times observed, that immerst Bodies have been concluded to weigh more in the Water than really they did; because, through such a want of Heedfulness, as is not uncommon, the Experimenters did not take notice, that if the string were too short, or the Vessel too full; the vibrating Motions

ons of the Ballance, would, at one time or other, carry down the Scale, the suspended Body was ty'd to, so low, as to make one part or other of it touch the Surface of the Water: some Drops of which Liquor would readily stick to it, and, because they adher'd to the nether part of it, would lye concealed from an Eye that was not prying, and by consequence would sensibly add to the Weight of the Scale, and make the Body be thought heavier than indeed it was; which Over-sight must needs be very prejudicial, when one makes Experiments that require Exactness.

7. But the most usual Cause of Mistakes in Hydrostatical Tryals, (especially such, as are made on small Bodies) wherein a little Error may be greatly considerable, is this; that Men are wont to think it sufficient, (in these Tryals) that the Body to be examined, be totally immerst in the Water; whereas it does not only often, but most commonly happen,

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that the given Solid, and the string that is tyed about it, carry down with them divers Particles of Air; and perhaps too, it may find and extricate others, that lay concealed in the Pores of the Liquor it self; which *Aerial* Particles fasten themselves to the little Asperities, that they meet with on the Surface of the immerst Bodies, in the form of Bubbles, which, like so many little Bladders full of Air, endeavour to buoy up the Body they adhere to; and on that account do, in Proportion to their Number and Bigness, lessen the Weight, which the immerst Body would otherwise have in Water. And therefore, great care is to be had, especially in nice Experiments; that, by shaking the string, and warily knocking the Body against the sides of the Glass, the adhering Bubbles may be displaced, and emerge to the top of the Water. And I shall add a desire, that on some occasions this Caution be made use of more than once in the same Tryals; because I have several

times

times observed, that now & then after the immerst Body was freed from the first Bubbles that appear'd about it, others did succeed, before an end was made of weighing the Body; out of some of whose unperceived Cavities, or Pores, (whether superficial or lying deeper) perhaps the latent Air could not easily on a sudden be driven by the Water. I have been the more Circumstantial in explaining the summarily proposed Method of Weighing Bodies in Water, because Experience hath shewn, that 'tis not near so easie, as, upon the first reading of it, one would presume; to be exact in the Practice of it.

Having obtained the Weight of a Body proposed; First, in the Air, and then in Water, according to the Method plainly delivered; 'twill not be difficult to discover *Practically* the Proportion in Weight, between the Solid and the Liquor. I say *Practically*, because the Rule is easie enough, tho' the Demonstration is not so readily to be understood by them, that

are not acquainted with the Principles of the Hydrostaticks. The *Theorem*, upon which our Practice is grounded, was first, that we know of, delivered by the most sagacious *Archimedes*; whose Commentators have busied themselves in demonstrating it in a Mathematical way, as I have since endeavoured to do in a Physical way, and more easie to Naturalists in the Hydrostatical Paradoxes. *Archimedes's* Proposition is this, *That a Body, heavier than Water, weighs less in Water than in the Air, by the Weight of as much Water as is equal to it in Bulk or Magnitude*: Whence 'tis not difficult to deduce a Rule sufficing for our present purpose. For if you subtract the Weight of the Body proposed, whilst it is every way environed with Water; from the Weight of the same Body, which it was found to have in the Air; the residual Number or Difference gives you the Weight (taken in the Air) of as much Water as is equal in Magnitude to the Solid proposed;

posed; so that, having now two Bodies, one Firm, and the other Liquid, together with the Weight of each of them apart; to find their Proportion, you need but divide the greater by the lesser; and the Quotient compared to One, that is, to an Unite, will be the Antecedent the of the Proportion desired between the solid Body and the Water; which is mentioned, but, as it is the Liquor that is generally employed in these Experiments, for otherwise the Rule will hold, *mutatis mutandis*, in other Liquors, as well as in Water.

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CHAPTER. III.

AND now having premised these Remarks, and thereby made way for the clearer Understanding of the subsequent part of this Paper; we shall proceed to the Examples, that this not unnecessary Digression has diverted us from propounding.

There is a deeply Red and Opaque Mineral, that commonly passes in the Shops under the Name of *Lapis Hematites*, tho' it seems to have more Affinity to that which divers Authors call *Schystos*. But whatever be the most proper Name that belongs to it, it is an hard Fossile, which, tho' little used by our English Physicians, is in several Places abroad in great Request; & that not without cause, as far as I can judge, by what I yet know of it; and especially, for that Somniferous Quality, that may be observed in some of its Preparations. But 'tis not here, tho' 'tis elsewhere, my Purpose to deliver its Medicinal Virtues; but only to examine, whether, according to our Method, it ought to be concluded to abound with Metallick Particles, (perhaps but Embryonated,) to whose Intermixture some of its Virtues may probably be ascrib'd. Therefore, in a very good Ballance, having weigh'd a piece of English *Hematites*, that chanced to amount to about  $\text{3ij} \frac{1}{2}$ , First, in the Air,

and

and then in Water; we found its Proportion to this Liquor, as 4<sup>1</sup>/<sub>2</sub> to 1. At which Ponderosity, if I had not formerly made the like Experiments, I should have been surprized; as you probably will be, when you consider, that this Metalline Stone did not very much want of almost twice the Weight of a mere Stone of the same Bulk. This great Weight much confirmed me in the Conjecture I had made, that in this Lump was contain'd a good deal of Metalline Substance. And this induced me (to add that upon the by) to examine my Guess, by subliming it, when finely powdered, and diligently mixt with an equal, or double, Weight of *Salammoniac*. For then having tasted, with the tip of my Tongue, of this *Saffron-coloured* Sublimate; I found it; as I expected; very Astringent or Styptic, as divers Preparations of *Mars* are wont to be; and, for further Proof, having put less than a Grain of it into a spoonful or two of good Infusion of Galls; there was immediate.

ly produced a Black, and as it 'twere Inky, Mixture.

*Lapis Lazuli* is sometimes made use of by *European* Physicians, but more frequently by *Arabian* and other *Eastern* Ones, for divers purposes, but especially to make Evacuations by Vomit. This Emetick Faculty seemed, likely enough, to belong to it upon the Score of a Metalline Ingredient; and accordingly, having examined Hydrostatically, a piece that was judged moderately rich, we found the Proportion of it to an equal Bulk of Water, to be as 3. to 1. which argues, That, notwithstanding its briskness in Operation, it contained a much lesser Proportion of Metalline Substance, than *Lapis Haematites*, or divers less Operative Minerals.

Observation about the Loadstone, as 'tis a Mineral.

I elsewhere shew, that the Loadstone may be applyed to Medicinal Uses, and that it emits *Effluvia*, that are not Magnetical, and may have sensible Operations upon the Body of Man. On which account, it was not improper

improper to examine it Hydrostatically ; by which means I found, that the Weight of a Lump of Loadstone, that I judged to be either *English* or *Norwegian*; was in Proportion to Water of the same Magnitude, as  $4\frac{2}{3}$  to 1. But of the specifick Gravities of Loadstones, much more may be met with in another Paper.

*Lapis Calaminaris* is often enough used in Physick, especially by Chymists, to dry ; and to imbibe Acidities. For which Uses, I prefer it before divers more famous Drugs : But, tho' 'tis wont to be imployed, only as an external Remedy ; yet some things, that I found in some uncommon Chymical Preparations of it, made me think, it may deserve to be further examined and tryed. A famous and not unlearned Empyrick, to whom I willingly communicated some Processes, that he desired of me ; when I asked him about a Medicine, whose Success brought him a great number of Patients, for griping Fluxes, and some Dysenterical ones ; candidly disco-

discovered his Medicine to me, and solemnly assured me, it was nothing, but pure and well-ground *Lapis Calaminaris*, seasonably given in a just Dose; as in a fitter place I have more fully declared. This made it obvious for for me to conjecture, that *Lapis Calaminaris* participates of a Metallick Nature, as may be argued from its Operation upon Copper, which is thereby turned into Brass. Wherefore weighing a piece of this Fossile, first in Air, and then in Water, it appeared to be to this Liquor as 4<sup>1/2</sup> to 1.

If I had not among other Papers lost Some, wherein I had Registred a good Number of Tryals of this kind made upon differing Fossiles; 'twould be easie for me to add to the four already recited, others manifestly conducing to the same Purpose. But presuming, that those already delivered may at present suffice; I shall now subjoyn a few Observations, whereof the *first* may become the Candor and Impartiality of a Lover of Truth, and the rest inti-

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mate some further Uses of the Hydrostatical Way of exploring hard and ponderous Concretions, hitherto treated of.

I must not therefore forbear to admonish you, that, *tho'* when an hard Fossile propounded, is found to be much heavier than Chrystal of the same Bulk; 'tis a very probable Token, that in the Solid Concretion, there is a notable Portion, greater or lesser, of some Metalline or other ponderous Mineral Body, whence its good or evil Qualities, in reference to human Bodies, may probably be deduced; Yet, this hinders not, but that 'tis very possible, for a Fossile to be endowed with Medicinal Virtues, or to have noxious Qualities, on the account of a Portion of extraneous Matter; tho' its specifick Gravity doth but little exceed that of Chrystal, or the advantage seem but inconsiderable. For, (to pass by other Reflections) a very small Proportion of Adventitious, Metalline, or Mineral Substance, if it be of an

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Operative Nature, may, in some Cases, suffice, to diffuse its self through the rest of the Mass, and impregnate it with active Qualities. Which may be partly Illustrated, and partly Proved, by some Experiments that will be hereafter met with, in one of the Chapters.

#### C H A P. IV.

Use II.

**T**O hint somewhat about the further Utility of our Hydrostatical Way of Inquiry; I shall take notice in the first place, that it may assist us to guess, with probability, whether a Mineral Body propounded, as likely to be a Stone, or of a stony Nature, be so indeed. Thus Coral, for instance, is by some thought to be a Plant, by others a *Lytho-dendron*, but, by the greater Number, 'tis reckoned among Precious Stones. In this Dissent of Opinions, the specifick Gravity may be of considerable Use.

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Wherefore, we thought fit to weigh a piece of choice and well coloured red Coral; first, in the Air, and then in the Water, and found its Proportion to the Weight of as much of that Liquor, to be as 2  $\frac{1}{2}$  to 1. So that its specifick Gravity much favours their Opinion, who take it to be a Stone, since it not only equals that of Chrystal, but somewhat exceeds it.

There are Some, that will have Pearls, because of their Hardness, and their being treated of by Jewelers, and others that write of Gems, to be of a stony Nature. Wherefore I thought fit examine their Ponderosity also. But not having now with me any Tryal of that kind; I shall substitute One that I made upon a monstrous Pearl, that was presented me by a Person that took it out of the Oyster. I call it Monstrous, because tho' it be well enough coloured, yet its Shape is irregular, and its Bigness extraordinary; as is also its Weight, amounting to full 206 Grains. This  
being

being weigh'd in Water, its Proportion in Gravity to an equal Bulk of the Liquor was found to be as 2  $\frac{1}{2}$  to 1. So that, its specifick Weight was much about the same, with that of Chrystal. There are Many, that take the Stones formed in Mens Bladders, for as true and genuine Stones, as Those that Nature forms in the greater World; and speak much, and sometimes not without ground, of the great Hardness of Divers of them. But, tho' I deny not, that, in a laxer Sense, they may well enough pass for Stones; yet I should rather call them *Animal Stones*, than simply *Stones*; this Name having been constantly and generally used, to signify Mineral or Fossile Stones: which, by our Way of Exploration, may be easily distinguished from human *Calculus's*, and other like hard Concretions, found in the Bodies of some Animals. For, having examined a good Number of these Stones, I found, that not only the Chymical *Analyses*, I made of them, of which

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I elsewhere give an Account, manifested them, how hard soever they were, to be Concretions belonging to the Animal Kingdom, not the Mineral: But, by an Hydrostatical Examination of divers of them, I found them to differ much, in specifick Gravity, from true Fossile Stones. Of this you will, in its proper place, meet with several Instances; so that it may here suffice to mention Two, that now chance to come to hand. Namely, that a *Calculus humanus* weighing above 3vjls was found to be in Proportion to an equal Bulk of Water, as  $1\frac{7}{10}$  to 1. And another, that weighed 3iv and above an half, in the Air, being also weighed in Water, appeared to be to this Liquor, as  $1\frac{6}{10}$  to 1.

I mention these Stones as belonging to the *Materia Medica*, tho' they are lookt upon rather as Diseases, of which, indeed, they are very sad Productions, because a famous and experienced Physician, that Practised long in the *East-Indies*, and had better

ter Opportunity than almost any *European* had before him, to try the Virtues of *Bezoar*, does either equal or prefer the *Calculi*, we are speaking of, even to *Oriental Bezoar*.

And to shew, that Men are not the only Animals, wherein Stone-like Concretions differ in specifick Gravity, (and so may be distinguished, by that difference,) from Chrystal and such like true Stones; we shall subjoyn Two or Three Experiments, made upon choice *Bezoar* Stones, not exceeding a middle Size, such being the likeliest not to be adulterated. The first of these weighing in the Air  $3\text{ij}$ , and odd Grains, was found to be in Proportion to Water of the same Bulk, as  $1 \frac{47}{100}$  to 1. Another weighing somewhat less than  $3\text{ij}$ , was to the Weight of an equal Bulk of Water, as  $1 \frac{13}{100}$  to 1. I might add divers other Instances of the like Import; and tho I think them not necessary, yet I shall subjoyn One more, because 'tis afforded by a *Bezoar* stone, taken out of another of  
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the same kind: This Kernel-stone, if I may so call it, being Weighed in the Air wanted Nine Grains of  $\text{ziii}$ , and its Proportion to Water of the same Magnitude, was found to be as that of  $1\frac{1}{5}$  to 1. In all which Instances, we may observe, that these Animal Stones not amounting to twice the Weight of Water equal to them in Bulk, have less of specifick Gravity, by above a Fifth part, than a true Fossile Stone (such as Chrystal) is wont to be endowed with.

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### CHAP. V.

**T**HE Use lately proposed of our Hydrostatical Way of Exploration, suggests to me Another, which may be deduced from it, as a kind of *Corollary*. Use III.

This comprehends two, somewhat differing, Ways of applying the Observations, we have lately mentioned: For first, we may by the Hydrosta-

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ticks be assisted to discover, with Probability, the resemblance, or the difference that may be between Bodies of the same Denomination, so that some subordinate *Species* of them, may, perhaps be distinguished, as well as several *Individuals* of the same, or lowermost, *Species*. Since, for Instance, we have found a notable difference between the specifick Weights of several Loadstones, that were dug up in several Countries or Mines ; if greater Number and Variety of Experiments, of this kind were made, we should possibly find, that, *Ceteris paribus*, the Loadstones of one Country, or of one Mine, are considerably heavier than Those of another ; as, if I mistake not, I usually observed, the *Norwegian* and the *English* Loadstones, to be heavier *in Specie*, than Those that are said to come out of a warmer Region, *Italy* ; whose Island of *Elba* abounds with Mines, whereof I saw one entire Mass, that I judged to weigh a great many hundred of Pounds. And this difference  
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of Weight between Fossiles of the same kind, when 'tis considerable, may be of good use to help us to distinguish between the Stones of the same lowest *Species*, that are proper to differing Countries or Mines. But, in Case the unequal Weight proceeds, as it often does, from an Adventitious Matter, that insinuated it self into the more genuine Matter of the Fossile, whilst 'twas Fluid or Soft, it may much assist us to guess at the greater or lesser Purity of Homogeneousness of the Fossile proposed; which Discovery may, on divers occasions, be of no small use to the Physician, the Jeweller, or the Naturalist.

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CH A P. VI.

**B**UT the Second thing comprized in our *Corollary*, may in divers Cases be of much greater Utility and Importance, as being very

Use IV.

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proper to help us to discern genuine Stones, whether Animal or Mineral, from counterfeit Ones; which too often pass for true, to the great prejudice of Physicians and Patients, and the great Loss of *Lapidarie's*, and their Customers. For *as* there are few Qualities appertaining to ponderable Bodies here below, that are so radiated, (if I may so speak) as their Ponderosity is. So there is scarce any Quality, wherein 'tis so difficult for *Impostors*, to make a notable Alteration unperceivedly, as the specific Gravity. I said, for *Impostors*; because, *tho'* in several Cases, 'tis not so very difficult, to alter the specific Weight belonging to this, or that, kind of Bodies; yet in those very Cases, it may be exceeding difficult, and perhaps impracticable, to make a considerable Change in that Quality, but by such Additions, or Operations, as will make a sensible Change in some other Qualities too, and thereby expose the Fallacy to be discovered. And this will especially prove

prove difficult in many Cases to vulgar Cheats, and Counterfeiters, or Adulterators of Gems, and other valuable Minerals ; because the little knowledge they have of the Numerousness, and Variety, of Natural and Artificial Productions, confines them to a small Number and Diversity of Means, to accomplish their fraudulent Designs. And whilst they are intent, but upon counterfeiting the more obvious Qualities of things; and perhaps of eluding the known and vulgar Tryals Men are wont to acquiesce in; they are not like to take Care to maintain the specifick Gravity, and secure their adulterated Wares, against an Hydrostatical Way of *Examen*, which, probably, they never so much as heard of. By this means, several Perls, for Instance, may be discovered to be Counterfeit, without, in the least, injuring them. And I remember, That some factitious Corals, that, for Divertisement, I made, to shew what might be done in that kind; were, notwithstanding

standing their fine Colour, Shape, and Glossiness, easily discoverable, by their having a specifick Weight manifestly exceeding That, which belongs to natural Corals.

Before I knew better Ways, I have sometimes, for Recreation, by the help of *Minium* made Pastes, or factitious Gems, which, tho' transparent, and finely enough coloured, yet, because they contained some vitrified Lead, added to the other Ingredients to promote the Fusion, were liable to be detected by an easie Hydrostatical Tryal of their Ponderosity. I have likewise seen a fair *Bezoar* Stone, that so resembled a genuine Stone, That a great Price was set upon it. But being brought me to be judged of, I made little doubt of its being Counterfeit, by reason of its appearing to me as heavy as a Mineral Stone of that Bulk; tho' the Possessor being loth to expose it to an uncommon Tryal, I could not so cogently evince, that I had a clear Reason to disadvise the purchase of it.

CHAP.

## C H A P. VII.

**A**FTER these Instances, (which are not the only, that might be al- Use V.  
 ledged of this kind) the affinity of the Subjects invites me to take notice of another Use, or, at least, a Variation of the former, which may be made of our Hydrostatical Way of examining Solids. For it may, on divers occasions, assist us, to make probable Estimates of the Genuineness, or the degree of Purity of several Bodies, that are, or may, usefully be employed in Physick; tho' they be not Stones or Minerals, provided they be heavy enough to sink in Water. For when we have once found the specifick Gravity of a Concretion of this sort, that we know to be Genuine, and well-conditioned in its kind; this degree of Ponderousness may serve us for a kind of Standard,

whereby to judge of others, of the same Denomination, or that are said to be of a like Nature.

To illustrate a Remark, that has no more of Difficulty in it than This, fewer Instances will suffice, (if any be necessary) than you will meet with in the following Part of this Tract, wherein they will opportunely occur. And therefore, instead of setting them down in this place, I choose to give you an Advertisement, that would surprize you, if I had not formerly hinted somewhat, applicable to the same purpose, by no great Variation. For that which I am about to observe to you, is, That, I think, there should be made a great difference between the Estimate, that Men make of some Stones, to which the Shops give the Name of Gems, according as the Estimate is to be made by Jewellers and Goldsmiths, or by Physicians and Chymists. For the Tradesmen, who usually aim but at the Beauty and Lustre of the Gems they would Sell, may justly esteem those

those *Ceteris paribus* the best, that are *in Specie* the lightest, because such are generally more uniform as to Sense, and more Transparent; and also, receive their Colour from Pigments of finer Parts. But, on the contrary, those, that in Gems seek mainly, if not only, for the Medicinal Virtues; may justly value Those most, that are most Ponderous: as having more plentiful Portions of the Metallick, or Mineral, Substances, whence the greatest part of their Virtues is, as has been formerly noted, in Probability, to be derived, And this difference in specifick Weight, in Stones that have the same Name given them, I sometimes found to be far greater, than one that has not try'd it would imagine, as may appear by some Instances, applicable to this Argument, that will hereafter be met with. But yet, I would not hence infer, that even such Stones, whether transparent or not, as appear fine, and are but light in their kind, must be devoid of Particles, whether

whether Metalline, or of kind to them, whence they may be endowed with considerable Medicinal Virtues. For there are Mineral Pigments of so subtle a Nature, that so small a Quantity as will scarce make them sensibly heavier than Gems that are less, or perhaps not at all coloured, may be diffused through the whole Matter; and, at least, impregnate every sensible part of it: This I shall Illustrate by the following Experiment, devised for that purpose.

Five Grains of powdered *Zaphora*, being mixed with  $\text{ʒj}$   $\text{ʒss}$  of finely powdered *Venice* Glass, and kept a full hour in Fusion in a Furnace, that gives an exceeding violent Fire, afforded a transparent Mass, that was throughout of a fine blew Colour, and that deep enough; so that one part of the Pigment sufficed to tinge, by Fusion, above an hundred parts of the Glass: And when for Curiosity, we made the Proportion of the *Zaphora* a little greater, taking Eight Grains of the Pigment to  $\text{ʒj}$  of Glass, that

that is, One to sixty; the Mixture having been kept for the like time in strong Fusion, the Mass was so deeply coloured, that the Proportion of the Tinging stuffe to the rest of the Water, appeared too great to make a handsome Gem.

And further to manifest, that a Quantity of Metalline Matter, tho' it be but very small, may suffice to give a Tincture, and so to impart a Virtue to a Glassy Body, and even to Gems; I shall add an Experiment, that perhaps you will think somewhat strange. I had long conjectur'd, that there was in *Granats*, especially in some that were deeply coloured, pretty store of Metalline *Corpuscles* of a Martial Nature, and that those *Corpuscles* are more than sufficient for the *Granate* it self, into whose Composition they enter, tho' not visibly, because of their extream Minuteness. Upon this supposition, I took a *Bohemian*, or rather *German, Granate*, (for I never saw any *Bohemian* so large) that I had kept by me for a Rarity, because

of

of its Bigness and deep Colour, tho it was not a fine Stone to look on, notwithstanding its being transparent in those Edges that were thin. This being reduced to very fine Powder (but not in an Iron Mortar, lest should take something from the Metal) we exactly mixt Eight Grains with an Ounce of finely pulverized Chrystalline Glass; afterwards the Mixture was kept two hours in a Furnace, that gives a stronger Fire than ordinary VVind-Furnaces, by which means we obtained, as I expected, a pretty uniform Mass tinged of a sufficiently green Colour, such as prepared Iron, or Steel, gives to pure Glass.

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## C H A P. VIII.

**W**Hat has been hitherto delivered, may serve to shew, in some measure, the Uses of our Hydrostatical Way of examining Drugs, upon a Supposition that they are Solid, and neither very minute, nor too light to sink in Water. But I must not forbear to confess, and even give

give Notice, that there are many Simples, and other ponderable Substances, that may, upon good Grounds, be said to belong to the *Materia Medica*; which yet want One, or More, of the newly expressed Conditions. Wherefore I must not conceal, that there are Three things, which, tho' not necessary to the Understanding of the Usefulness of the foregoing Part of this Discourse; may, if they can be performed, much conduce to Facilitate (for I dare not say, to Compleat) the Hydrostatical Way of examining Bodies, heavier *in Specie* than Water. And therefore, tho' I confess it no easie Task to surmount the Difficulties to be met with in this Attempt; yet I shall endeavour to lessen them as much as I can, by offering to you the Expedients, that I was wont formerly to make use of in the Three Cases, I am about to mention: Namely, *First*, When the Body to be examined was Liquid, and consequently, I could not be immediately taken hold of by an Horse-hair, or  
any

any other slender String. *Secondly*, When the Body proposed was either in the Form of Powder, or consisted of Fragments that were so small, that it 'twas not possible, or, at least, not fit, to fasten each of them to an Hair; and suspend it after the manner of a Body of a greater Bulk. And, *Thirdly*, When the Solid to be Hydrostatically examined, though great enough in Bulk to be tyed about, was dissoluble in Water; and consequently unfit to be weighed in that *Medium*: Since therein its Gravity must continually decrease, whilst the Operation was performing.

As to the First of the Three Difficulties; lately mentioned, I suppose, I need not solicitously premise, that the Liquid Substance, to be Hydrostatically examin'd, ought to be heavier *in Specie*, than the Water, or other Fluid, 'tis to be weighed in; and of such a Nature, as not to be apt (at least, speedily) to mingle it self with it: since, otherwise, the proposed Liquor will either emerge in  
that

that it should be weighed in, or else be confounded with it, and so retain no distinct Mass, or Gravity.

Supposing then, that the Liquor, to be examined, has belonging to it the Two newly recited Conditions, we made use of this Expedient to explore its specifick Weight. We took a small Jar, or wide-mouthed Glass, capable of containing an Ounce or two of common Water, and weighing in the Air about, Three or four Drams (more or less, as occasion requires.) This Glass, which, for Brevities sake, we are wont to call Hydrostatical, or else Glass-Bucket; we weigh very carefully once for all, first in the Air, and then in the Water, and by the difference of the Weights we find, according to the known Hydrostatical Method, a Weight equivalent to That of the Substance of the Glass in Water; so that such a Weight, being put into the opposite Scale of the Ballance, the Vessel hanging under the Surface of the Water, may be considered

dered as having no Weight at all, that is, no Præponderancy. And consequently, the Weight of a Body contained in this Bucket may be looked upon, as That of the Body it self in Water, without being increased by that of the Vessel; so that, in our Instance, the Bucket makes a Mass of Quick-silver, tho' Fluid, as ponderable as if 'twere coagulated into a Solid Body.

The Glass-Bucket being thus provided once for all, we put the proposed *Mercury* into it, and weigh them together in the Air; whence deducting the already known Weight of the Vessel it self in the Air, the Residue gives the Weight of the Quick-silver alone in the Air. This done, by the help of an Horse-hair, we tye the Bucket to one of the Scales, (or to either end of the Beam,) and letting it, with the Quick-silver in it, slowly sink into a Glass, or other Vessel, competently full of fair Water, and hang so, that the Bucket may not any where touch,  
either

either the bottom, or the sides of the larger Vessel ; we reduce by Weights, put into the opposite Scale, and added to the formerly mentioned Counterpoise of the Bucket in the Water, the Ballance to an exact *Æquilibrium*, without raising the Bucket quite to the Surface of the Water ; this newly obtained Weight, of the immerst Quick-silver , being deducted from its Weight in the Air, 'tis easie, by the known Hydrostatical Method, to obtain the Proportion in Gravity, between the given *Mercury* , and an equal Bulk of Water.

To expedite this Operation , it may be convenient to have in readiness (as I was wont to do,) a couple of Weights, of Lead, or Tin ; the greater exactly equal to the Weight of the Glafs-Bucket in the Air, and the other equal to the Weight of the same Bucket in Water. For, by keeping these two Weights constantly in readiness, One has at hand a Counterpoise of the Vessel, in which soever of the two *Medium's* 'tis employ'd

in; which saves them, that have frequent occasion to use the Ballance, much of the time that must otherwise be spent to adjust it.

This Advertisement being premised, the lately propounded Operation will be best understood by an Example; we took a small Glass-Jar capable of holding about  $\frac{3}{4}$  of Water, and put it into one Scale of a tender Ballance; whose other Scale we furnish'd with a Counterpoise, or Weight, equal to the Glass. Into this little Vessel, we then put  $\frac{3}{4}$ , that is, Four hundred and eighty Grains of *Mercury* (affirm'd to be *Spanish*, which is counted the richest) and the Glass with this *Mercury* in it, was, by an Horse-hair, made to hang from one of the Scales, into a deep Glass Vessel of Water. Whilst it was in that state, there was in the opposite Scale a Counterpoise to the Glass it self in the Water, so that the Drums and Grains, that 'twas requisite to add, gave us the Weight of the Quick-silver only, the Weight of

of the Glass, being already accounted for. But Care was first taken, that the open-mouth'd Vessel should be every where environed with Water, and diligently freed from adherent Bubbles; and that a piece of Horse-hair should be added to the Counterpoise, to compensate that part of the String or Hair tyed about the Bucket, that was in the Air, intercepted between the Scale, it was fastened to, and the Surface of the Water. By this means, we found the Weight of the Quick-silver in that Liquor, to amount to 446 Grains, which being subtracted from the Weight of the Quick-silver in the Air, the difference was 34 Grains, by which the greater Number being divided, the Quotient was 14 and about  $\frac{1}{10}$ . So that the *Mercury*, imploy'd in this Operation, appeared to be in Gravity to Water of the same Bulk, as 14  $\frac{11}{100}$  to 1. I said, the *Mercury* imployed in this Operation, because, in former Tryals, I scarce found common Quick-silver,

that was bought in Shops, to weigh full Fourteen times, and sometimes scarce 13 and  $\frac{1}{2}$  as much as a Bulk of Water equal to it ; whether the Ponderousness of our last used Mercury proceeded from hence ; that, as some Chymists extol *Spanish Mercury*, as participating more than others of a Golden Nature, (which Opinion, a Tryal, that I purposely made of That imploy'd about the late Experiment, did not disfavour ;) So, there was in this of Ours something of unfixt Gold, that somewhat increased its Weight ; I leave to further Enquiry.

If you can command, as I cannot, the Learned *Ghetaldus's Archimedes Promotus* : Since, as I am informed, He there sets down the intensive Weight of Quick-silver Hydrostatically found ; it may be worth your while to consult that scarce Book, and compare the things you may meet with there, relating to Quick-silver, with what I have now delivered. To which I shall add,  
That

That this I may here give you Notice of in general ; That, having on Chymical and other Accounts, had more occasion than most Men, to make Tryals of this sort, I did not find all running Mercuries; tho' they did not appear adulterated, to be precisely of the same Weight: Nay, even destilled Mercuries, if once combin'd with Metalline Bodies, and particularly, if they were animated, and drawn from fine Gold; I found to differ more from common Mercuries sold in Shops, than These did from one another ; and even between common Mercuries , notwithstanding their having been Destilled, we found a notable Disparity. But to inlarge on this Subject, were improper in this Place, where I mentioned the Weight of Mercury : But to give so clear (tho' but single) an Instance of the Way of measuring the Weight of ponderous Liquid Bodies in Water, as may warrant me to say ; That, by this Method, tho' not always with the same ease, we may explore the spe-

cifick Weight of other Liquors, that are in equal Bulk heavier than Water, and yet are indisposed to mingle with it ; such as are the Chymical Oyls of Cinnamon, Cloves, *Guajacum*, &c. But the chief thing, that has made me the the more Circumstantial in delivering the foregoing Experiment, was, that this practical Direction, for weighing one Liquor in another, will hereafter appear to be applicable to useful Purposes, especially when we come to mention, in the following Chapters, several Cases, wherein Liquors of a Nature very different from Water, may be substituted in its stead.

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## C H A P. IX.

**A**S for the Way of Examining Hydrostatically the Powders of sinking Bodies, such as *Minium*, *Putrie*, &c. or such small Solids, or Fragments of greater Ones, as by reason  
of

of their Littleness or inconvenient Shape, are *singly* unfit to be tyed with an Horse-hair to the Ballance ; as the Fragments of Rubies, and other precious Stones, wont to be sold by Weight at the Drugsters or Apothecaries Shops : the Way of discovering the Weight of these in Water, differs not much from That lately delivered of weighing Quick-silver in that Liquor. For on these occasions also, we imploy such a Glass-Bucket, as was lately described ; and having made it very dry, as well within, as without ; We put into it the Metal-line *Calx*, or other heavy Powder, or a convenient Quantity of the Fragments of Gems, or a competent Number of small, tho' intire, Bodies, as Pieces of Native *Cinnabar*, *Seed-pearl*, &c. and proceed with these, as we did with Quick-silver. Only this Caution is to be heedfully taken along, that we warily, and little by little, put into the Bucket, whilst 'tis yet kept in the Air, and hath the already weighed Powder, or Frag-

ments in it, a convenient Quantity of the same Water, 'tis to be weighed in; that the Liquor may have time to insinuate it self between the dry Bodies, and even the *Corpuscles* of the Powders, and expel thence the Air, that was harbored in the Intervals betwixt them; which little *Aerial* Portions, if not thus seasonably expelled, would, upon the immersion of the Vessel, produce in the Water store of Bubbles, that would buoy up, or fasten themselves to the Fragments, or other small Bodies, and make the Experiment uncertain, or fallacious. And if it be a *Powder*, that is to be weighed; unless it be before hand thoroughly wetted, and thereby freed from *Aerial* Particles, and reduced to a kind of Mud; there is Danger, that some dry *Corpuscles* of the Powder, will, when the Vessel is under Water, be buoy'd up, and get out of it, and, floating on the Surface of the incumbent Water, take off from the true Weight, that the immerst Powder should have in that Liquor.

If

If this Way of examining Bodies be carefully imployed by a dextrous Man, furnished with a tender Balance, it may be of considerable use, not only to Physicians, Druggists, and Apothecaries, that are conversant with the more precious Kinds of sinking Bodies, that belong to the *Materia Medica* ; but also to Lapidaries, and Gold-smiths, whom it much concerns not to be imposed upon by counterfeit Gems, or by other Stones of price, that are not duly conditioned, in their kind. Thus the Fragments of the *Five precious Stones*, That (upon what grounds, I now inquire not,) are made Ingredients of some Noble Compositions, as *Confectio Hyacinthi*, &c. these Fragments, I say, may each sort of them apart be usefully examined by their Weight in Water, by him that knows the true specifick Gravity of a parcel of the finest, or else of such as he judges to be fittest for his purpose. And, to add That upon the By, whereas *Granates* are reckoned among the

Five

Five Medicinal precious Stones, and in some *Pharmacopæa's* are preferr'd to the First place, as the best : I have found so great a difference, in point of Ponderosity, between *European Granates* and *American Ones*, whereof some were sent me as a Present from *New England*, and others, I my self pickt plentifully enough out of an odd *American Mineral*, that I suspected to contain them; that it was very obvious to think, their Virtues might be very different, if not as to *Kind*, yet, at least, as to *Degrees*: And *not only* such factitious Pearls as have deluded many, and sometimes even famous, Jewellers, (as one of themselves, that was Lapidary to a great Monarch, confessed to me) may oftentimes by this Expedient be discovered, especially if Mercury (tho' disguis'd) be imploy'd in making them ; *but*, we may probably by the same Method discriminate the natural Pearls of several Countries and Sorts, whereof I have seen a far greater difference than one would expect ;  
and

and I have somewhere yet by me natural Pearls of such various Colours, as well as Shapes, as have somewhat surprized even the Curious. But because it more concerns Physicians and Patients, to be able to make Estimates of Seed Pearl, that are on many occasions of good use to health; than to know the Genuineness of those bigger Ones, that are seldom made use of, but for Ornament; I shall here mention the result of an Experiment, which I find among my old Notes, to have been made by me, when I was furnished with very fine Oriental Seed-Pearls. For having examined these by the Way, we are now discoursing of, as judging them Orient enough to be fit to be Patterns, wherewith to compare Others; we found these to Water of the same Bulk,  $2 \frac{75}{100}$  (i. e.  $\frac{3}{4}$ ) to 1.

But in This, and in those other Tryals, whose Difficulty, or Importance, require, that we make them as exactly, as we are able. I must advertise you, that 'tis not fit to trust  
to

to the Steadiness of your hand, in holding the Ballance, but that you make use of a Gibbet, (as they call it,) or some other stable Prop to support it. For the Hand often shakes, and makes the Instrument that it holds, to do so : and oftner grows weary before the Scales have had time to play up and down, and at length settle in a determinate Scituation ; wherein if you miss of a true *Æquilibrium*, the Hand must undergo a new Pennance : Whereas, when the Ballance hangs on a stable *Fulcrum*, you have both your Hands to help you, and need not be tempted by Weariness to desist, before the Ballance be brought to rest in a perfect *Æquilibrium*. The Neglect or Omission of this Practice, I take to be one main Reason, (for the want of good Ballances, or of Skill to use them, is oftentimes Another) why so many of the Experiments, that require weighing, are Erroneous ; as they that cautiously examine them (as I have sometimes had occasion to do)

do) may easily find. And therefore, (to add That, upon the By,) I hope, you will not make haste to censure the Accounts I give of Hydrostatical Tryals, because they do not always agree with Those of other Mens; since perhaps they did not imploy, either more Diligence, or better Instruments, than I.

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## C H A P. X.

**T**He last of the Three Cases, formerly mentioned: Namely, *What is to be done, when the Body to be Hydrostatically examined, will dissolve in Water, or easily mingle with it?* Imports a Question, difficult and troublesome enough to be resolved. Nor can this *Examen* be performed by a single Operation, which yet sufficed in each of the Two foregoing Cases. And having seriously considered the Matter, the best Expedient I could then think of was, That, which divers

vers years ago, I propounded in an Assembly of the Royal Society, and grounded on this Reflection, That tho' the Body proposed could not be immediately weighed in Water, yet we may substitute another Liquor that will not dissolve it, and thereby investigate the specifick Gravity, in reference to *that Medium*; and then, by comparing the difference of those Two Liquors in point of Gravity, One may come to discover, What the Body proposed would have weighed in Water, in case it could have been kept there a competent time, without having any part of it dissolved. Considering then, that, except Quick-silver, the visible Fluids we can command, are either of an *Aqueous*, or of an *Oily*, Nature; and that most Bodies, whereof we can make Solutions in Liquors of the former, will not (at least, sensibly) suffer themselves to be dissolved by those of the later, Kind, whilst a proposed Solid is weighing in them: We presum'd that the most Saline Bodies,  
such

such as *Allum, Vitriol, Sal Gem,* to which may be added, *Borax, Sublimate, &c.* might be commodiously weighed in *Oleous Liquors.* Among these I made choice of Oil of *Turpentine,* rather than Oil-Olive, or any Chymical Essential Oil: *Partly,* because, being of common use, 'tis to be procured in sufficient Quantity, and, being very cheap, is seldom adulterated, as Chymical Oils are too often found to be; and, *partly,* because being a distilled Body, it may be presumed to be free from *Aqueous* Parts, of which Experience has shewn me, that common expressed Oil is far from being destitute: But because Two Liquors, that are indeed both of them Oils, are wont to have distinct Names given them in the Shops; I shall here intimate, that I do not, when I have my Choice, make use of that which many call the Oil of *Turpentine,* but of That which first comes over, which those that distinguish them, call the *Spirit of Turpentine:* I prefer This,

(I say,) because 'tis clear, almost like fair Water; whereas, That which is called the *Oil*, besides that 'tis less Fluid, is commonly of a Yellow Colour, which does lessen its Transparency, and may be compounded with some of the coloured Bodies to be weighed in it.

There are many Persons, that would find it very *difficult*, and to whom, on most occasions, 'twill not be *necessary*, to know the determinate Proportion in Gravity, between *Oil* of *Turpentine*, and the Solid that is weighed in it; and to discover, by the help of that Gravity, what the Body proposed would weigh in Water, in case it could be kept for a competent time in that *Medium*, without having any part of it dissolved therein. And therefore, *Tho'*, if you desire it, I shall, God permitting, annex the Method of performing this Task (which, you know, requires more Calculation, than every common Reader is able to go thorow with) to the end of this Tract: Yet, for

for the present it may perhaps be sufficient, as well as fit, that I give you notice, that those, that have not Skill enough to determine, by the Hydrostaticks, the Proportion between sinking Solids, and the Liquor they are weighed in, may yet be assisted by what we have delivered about *Oil of Turpentine*, to make a not unuseful Estimate, What is the specifick Gravity of divers Bodies, in reference to others of the same, or a differing, *Species*; and by that means, to make a probable Guess, Whether or no it be rightly Conditioned; if he be but provided with one piece of the Body, which he knows to be Genuine or well qualified. For This may serve him as a Standard, whereby to examine other Bodies of the same Denomination, that he may have occasion to Purchase, or to Sell, or to Employ. As, suppose a Trades-man be to buy a parcel of Sublimate, he may take an Ounce, for instance, or half an Ounce of some of That he knows to be good or rightly made: Then, having

F      carefully

carefully weighed it in Oil of *Turpentine*, and set down how much it weighs therein; if he takes an Ounce, or half an Ounce of the Sublimate, he would make Tryal of, he may weigh that, as he did the other, in the same Liquor, wherein if it give the same Weight with the Standard, 'tis a good Sign; but if it weighs not so much, 'tis a Sign that it has not its full or due Proportion of *Mercury*, and too great a Proportion of Salts, whence its comparative Lightness proceeds. The same Way of trying may be made use of, for the *Examen* of *Mercurius Dulcis*, and divers other Bodies, totally or partly, dissoluble in Water, as of *Allum*, which is often Sophisticated with some baser Salt, and of *Roman Vitriol*, which is sometimes either counterfeited, or adulterated by the help of *Roch Allum*, and a Tincture of *Copper*. And according as the Weight in Oyl of the Body proposed, recedes more or less from the Weight of the Standard, so the Adulteration may be probably concluded to be lesser or greater.

CHAP.

## C H A P. XI.

**B**Efore I go off from this Subject, 'tis fit that I give you notice, that the Hydrostaticks may supply us with another Way of Estimating the intensive Gravity of Bodies, Solid or Fluid, that may on some occasions be of good use. The Way I mean is this; we take a solid Body more than heavy enough to sink in Water, and carefully observe, once for all, its Weight in the Air; then we weigh the self same Solid, first in One of the Liquors we would examine, and then in another; and so onwards, if there be more than two: And having noted the difference between the Solid, and each of the Liquors, 'tis easie to find, according to the Practice elsewhere delivered, the specifick Weight of each, and the Proportions betwixt

them. And in regard 'tis but One and the same Solid, that is compar'd to the differing Liquors; whatsoever their Number be, it will not be difficult, to compare the specifick Gravities of those Liquors betwixt themselves, and to discover by the Weight of the *First*; That of any of the Others that One pleases.

The propos'd Way having been but Summarily delivered, it will not be amiss to subjoyn some Remarks relating to it.

And *First*, If you intend to employ but One Solid in your *Examen* of Liquors, 'twill be necessary you make Choice of such an one, as hath a much greater specifick Gravity, than is necessary to make it sink in *Water*. For there are some Liquors that are far, perhaps twice, more ponderous than This newly named. *Secondly*, The Body ought to be heavy enough to sink in all Liquors but Quick-silver, (for in That, none but Gold is ponderous enough to sink.) But if your Tryals are to be made upon

upon Liquors that belong to the Vegetable, or Animal, Kingdom, the Body you imploy need not be near so ponderous; tho' it ought to be more so than Water, because (as I found by Tryals purposely made) some Liquors, that are very Spiritous and Volatile, are yet much heavier *in Specie*, than Water. 'Tis not very easie to pitch upon such a single Solid, as may have all the Qualities in reference to our Purposes, that may be desired in it, if it be to be made use of for a long time. For *Thirdly*, Besides that, it ought not to lose of its Weight, (and consequently to change it,) by the insensible Avolation of *Effluvia*, and that it must be, as was freshly noted, of a considerable specifick Gravity. *Fourthly*, It ought not to be too big, or too intensely heavy, lest it be too heavy for a tender Ballance, or require too much Liquor to environ it. *Fifthly*, It ought to be of such a Texture as not to be dissolved, or corroded by any of the several Liquors, some

of which may be sharp and piercing *Menstruums*, that 'tis to be weigh'd in; and those too of differing Natures. *Sixthly*, It should also be of such a Make, as is not easily lyable to be broken, or otherwise spoil'd, that it may last, till all the design'd Experiments, tho' many, be made with it. *Seventhly*, and lastly, 'tis desirable, that it should be of a natural and uniform, as to Sense, and procurable Substance; that the Experiments, made with it, may be easily enough communicated to Others, and, if they think fit, tryed over again by them; and that, if any be judged worthy, they may be transmitted to Posterity.

Several Bodies there are, that I looked upon as more fit than most Others to be imploy'd about the Tryals, we are treating of. The chief of these were *Brimstone, Hard Wax, Ivory*, and *White Marble*. But tho' each of these, especially if fitly shaped, may be of use on some particular occasions; yet every one wanted

ted some of the desirable Qualifications lately mentioned. And therefore, I made much more use of Three other Bodies, not because they were such as I could Wish ; but because they were the least remote from being such, among those I could Procure. The *first* of these was a piece of *Amber* between Three and Four Drams in Weight, of an high Yellow Colour, but very Transparent, and of an uniform Texture and convenient Shape. This was judg'd fit to be employ'd, when we were to examine the lighter sorts of Liquors, such as common Water, Rain-water, &c. Wine, Brandy, rectified Spirit of Wine-Vinegar, and the Liquors drawn from it, Cydar, Beer, Ale, Urine, many Waters and Spirits destilled from Bodies belonging to the Vegetable, and to the Animal, Kingdoms. But 'tis not proper for the more ponderous kind of Liquors ; since 'twill not sink to the Bottom, but float at the Top, not only of some Liquors of the Mineral Kingdom, (as will

ere long appear ; ) but in several Liquors afforded us by the Saline parts of Bodies belonging to the Vegetable Kingdom ; as you will find within a few Pages.

The Second Body, I imployed, was a *Globular* Glass, which I caused to be blown at a Lamp, and to be Hermetically sealed at the Neck, which was purposely made very short, after there had been Lodged in it as much Quick-silver, and no more, as we guessed would serve to sink it in any Liquor, except Quick-silver ; This, by reason of its great Bulk, in reference to its Weight, was fit to discover Differences in Weight, minute enough between the Liquors 'twas weighed in ; and 'twas out of Danger of being corroded, even by sharp *Menstruums* ; and therefore, on divers occasions, I preferred this Instrument to any of the other Two ; but 'tis disadvantage'd by these Inconveniencies, *that* 'tis difficult to be made, or procured, *that* 'tis hard to be preserved, being very easie to

be broken, and *that* partly on this Account, and partly on Others, it can scarce be a fit Standard in reference to such Observations, as are to be communicated to Others, and transmitted to Posterity.

Wherefore for Experiments that are to be imparted & recorded, I made use of a Solid, which *tho'* heavier *in Specie* than was necessary to inable one to compare together the lighter sorts of Liquors, and to discover their minuter Disparities in point of Weight, is yet a natural Standard not subject to be broken without gross Negligence, nor to be dissolved, or corroded by the Liquors, 'twas to be immerst in, however of various Kinds, and very sharp, and ponderous enough to sink in all of them, except Quick-silver, and yet not near so ponderous, as the lightest Metals, or many Metalline Bodies; this Solid I speak of is Rock Chrystal, which I formerly represented, as for its Purity, Homogeneity, &c. fit to afford a Measure, to which other  
Bodies

Bodies may be compar'd in Weight, and by that means among themselves. And of this pure Concrete, we imployed an almost compleat Globe, (weighing in the Air  $\text{3ij } 3\beta$  Grains 3,) save that it had in one part of it two small Holes near one another, and easily stopt up with hard Wax, after there had been put through them an Horse-hair, by whose means the Ball was easily fastened to the Scale from whence 'twas to hang in the Water. The bigness of this *Globular* Body made it the more fit to discover the lesser Differences between Liquors in point of intensive Gravity. But because we may have oftentimes occasion to know the Weight of Liquors, of which, by reason of their Preciousness, or Rarity, we can command but small Quantities, as it frequently happens, if we be to try the Weight of Chymical Oyls, Tinctures, Essences, &c. We thought fit, for such Liquors, to provide a piece of Chrystal, such as Nature had framed it, *viz.* an *Hexagonal Prisme*,

*Prisme*, with a kind of Pyramide at the end, which is opposite to the extream, at which 'twas broken off from the Body, it grew on. For this clear and finely shaped Chrystal, (or, what is very near of kin to it, white *Amethyſt*) by reason of its oblong Figure, might be commodiously weigh'd in ſo ſlender a Cylindrical Glaſs, as required but a ſmall Quantity of Liquor to cover and ſurround a conveniently ſhap'd Body, that weighed, in the Air, but half an Ounce and ſixteen Grains. And to render the Obſervations, made with theſe two Bodies of Medicinal and other Liquors, (for there are ſeveral of theſe Tryals, that belong not to this Tract) the more uſeful to Experimenters, I ſhall here deſire you to take notice once for all, that the Ball of Chryſtal was to Water of the ſame Bulk, as  $2 \frac{57}{160}$  to 1 or thereabouts; and the Priſmatical Oblong piece of Chryſtal was to a Quantity of the ſame Liquor, equal to it in Magnitude, as  $2 \frac{66}{160}$  to 1.

I have the more particularly delivered the Way of exploring the Gravity of several Liquors with one Solid, because there may be made of it a couple of Applications, that may, on several occasions, be of use, not only to Chymists, Physicians and Apothecaries, but to divers other Experimenters, that are not of either of their Professions.

These Applications do, I confess, belong to another Paper, (*viz.* an Essay about some Uses of Chymistry improved) that was written divers years ago. But since, by reason of the loss of divers Leaves of it, I know not *whether*, much less *when*, 'twill come abroad, I shall at present borrow some few things of it to accommodate my present Design.

First then, the piece of clear *Amber* formerly mentioned, or some such convenient Body, that is not too little, nor *in Specie*, too heavy, may serve the Chymist, Apothecary, and others, to make probable GuesSES of the Degree of Spirituosity, or of Thin-  
ness,

ness, that is to be found in many Liquors belonging to the Vegetable, or the Animal Kingdom; which may be done with far less Error by this Way, than by those uncertain Signs, on which the common Ways of guessing are wont to be grounded. For having once provided a Liquor, by Comparison whereto One may safely make Estimates of Others of the same Kind, or Denomination, 'twill be easie, by observing the differing Weights of the *Amber* in several Liquors to judge of the Fineness of any of them in its Kind; for, *Ceteris paribus*, That is the thinnest, or abounds most in Spirituous parts, where the Solid weighs more than in the Other, as for instance, The *Amber* we imployed, that in Water weighed  $6\frac{1}{4}$  Grains, in common Red French Wine weighed  $8\frac{1}{2}$  Grains, in common Brandy of a pretty good sort, such as that of *Nantz*,  $17\frac{1}{2}$  Grains, and in vinous Spirits highly rectified  $34\frac{1}{2}$  Grains. The same Way one may imploy, to judge of the

the Strength of Spirits of Vinegar, *Acetum Radicatum*, &c. but with a great difference in the Application. For it may pass for a general Rule, That, 'tis probable, that, of Liquors destilled from Wine, Cydar, Ale, and other fermented Liquors, the Hydrostatical Body (if I may so call it) weighs more or less, according as the Liquor 'tis weighed in, is more or less Spirituous; but, on the contrary, in *Acid* Spirits and Liquors, the less the Solid weighs, the stronger One may repute that Liquor to be: That greater Decrement of Weight proceeding usually from the greater Proportion, it contains, of Salts that are not Volatile.

I must not here pretermitt one Convenience of the Way newly proposed, that may, in tract of time, save you some Money, and, at least, will enable you to Husband better, than in the vulgar Method you can, Liquors that you may have but small Quantities of, or that are worthy to be preserved. For, you know, 'tis usual

usual with many Chymists, and especially those that are more circumspect than others, to try the Goodness of their Spirit of Wine, or Brandy, or other Spirits drawn from fermented Liquors, by setting Fire to a spoonful of the Spirit to be examin'd, in order to see, how much of it is totally inflammable, and how great, or little, a Portion of Phlegm will be left behind. But, not here to mention the Scruples I propose in another Paper, about this Way of trying Ardent Spirits, I shall now only take notice, that, by the newly recited Way, you lose or spoil all that you try, and the better the Spirit is, the greater is your Loss, whereas by the Hydrostatical Way, the Liquor is examined without being destroyed.

'Tis now fit to add, that, by the help of the foregoing Observations, One may also make Estimates of *Liquors* of the same kind *not distilled*, whether fermented or not fermented; as several Sorts of Beer, or of Ale, or of Cydar,

Cydar, or of Juices of Apples, or of Pears, newly prest out. And the same Hydrostatical Solid may be employed, to compare with one another, in point of intensive Weight, Liquors of differing kinds, as Wine, Beer, Ale, Mead, Cydar, Perry, Verjuice, exprest Oyls, Essential Oyls of differing Bodies, &c.

But, in case the Liquors to be employed be very ponderous, *Amber* will not be a fit Solid to be examined about them; for I have found by Tryal, (what one would scarce suspect) not only that it would swim or float, in divers Liquors made by Solution of Salts, whether in the moist Air, or even in Water, such as Oil of *Tartar per Deliquium*, Solution of Salt of *Tartar* in as little Water as may be, and Solution of the Salt of Pot-ashes, &c. But some destilled Liquors would not suffer my pellucid *Amber* to sink to the Bottom, as I found by Tryal made with Oil of *Vitriol*, with Spirit of *Nitre*, and even with good Spirit of *Salt*.  
Besides

Besides, there may be another Use made of our Hydrostatical Solid, which may, on divers occasions, be as Serviceable to Experimenters in general, by assisting them to proportion, to their purposes, the Strength of the *Menstruums*, and other Liquors, they are to imploy; as the former use is to Destillers and Apothecaries, for discovering the Strength of the already prepared Liquors, that they would examine. For there are divers Experiments, that either do not succeed, or, at least, do not succeed so well, unless the *Menstruums*, or other Liquors, imployed in making them, be of a determinate Degree of Strength, (which is usually knowable by a certain Degree of intensive Weight.) This will be the more easily granted, if (as I have elsewhere shewn) the Strength and Spirituosity even of some Liquors, whose chief Virtue and Use is to be good Solvents, may yet be unfit to dissolve, as well because their Strength exceeds a certain Mea-

sure, as because, by their Weakness, they fall short of it; Of this, I remember, I gave an Instance in *Aqua Fortis*, whose strength, as it's Name intimates, is reckon'd the best Quality it can have; for I found, that if it were rectified so much as to make it as strong, as we could, or but somewhat less strong than that, it would not dissolve Silver, but required to be weakened by an Addition of Water; and I found, that the *Menstruum*, tho' it were not much rectified, would not near so well dissolve the Filings or Raspings of crude Lead, when 'twas moderately strong and fit to dissolve Silver, as when 'twas allayed with a considerable Quantity of Water, especially if afforded by Rain, or by Destillation. I shall add, that, in making Extractions from many vegetable Substances, for Medicinal Uses, Chymists themselves may fall into a Mistake, when they affect to employ their most rectified Spirit of Wine, as the best *Menstruum* for their purpose:

For

For the Medicinal Virtue of not a few such Bodies does not reside only in what Chymists call their *Sulphur*, and might perhaps more properly be called the Resinous Part, which indeed is best dissolved by such Spirit of Wine, as is carefully dephlegm'd; but also in a more Gummous, and, partly perhaps, almost Mucilaginous Substance, for whose Extraction a moderately Phlegmatick Spirit is more proper; because of the Aqueous Portion, that is mingled with the inflammable One; since we see, that some Gummous Bodies, as *Gum Arabick*, *Gum Tragacanth*, &c. are not disposed to be dissolved by the best rectified Spirit of Wine, as they are by Aqueous Liquors, as Water, weak Spirit of Wine, &c. and some, tho' dissoluble in both kinds of *Menstruums*, are yet less easily so in strong Spirit of Wine, than in waterish *Menstruums*; as may be observed particularly in *Myrrh*; for other Instances applicable to these Adver-

tisements belong to another Paper. And what has been now said, may serve to persuade you, that it may be of good use, on divers Occasions, to take Notice of the Degree of Strength of the *Menstruum*, or other Liquor, we employ about this or that nice Experiment ; that when we have occasion to reiterate it to the same Purpose only, we may be able to bring the Liquor we make use of to the same Degree of Strength with That, which we formerly employed, and by which the design'd Effect was produced. But, in Experiments that should be very Critically made, 'twill not be amiss to bear in mind this Caution, that if the Liquor be very ponderous *in Specie*, as Oil of *Vitriol*, or Oil of *Tartar per deliquium*, 'twill be fit to put something into the Scale, from which the Solid hangs, to make Compensation for that part of the Hair that is immersed, since Horse-hair not being of the same Specifick Gravity with this Liquor, (tho' it be presumed

sumed to be so with common Water) is to be considered, as a somewhat lighter Body, capable of buoying up the Solid a little; and therefore its Comparative Levity should be compensated.

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### C H A P. XII.

**B**ESIDES the Way, we come from discoursing of, there is indeed another Way, which we have, on divers Occasions, found useful, to compare different Liquors, that are of the same Magnitude, in point of Weight. This is done by successively filling a Vial greater, or smaller, furnished with a pretty long and slender Cylindrical Stem, to a certain stable Mark made near the Top, with the several Liquors to be compared together in point of Gravity.

But this Way I must here do no more than name, not so much because I speak of it in a convenient

place of another Paper, as because 'tis not Hydrostatical. But there is also another Way to discover, Whether or no, Two, or more, Liquors proposed differ in Specifick Weight, and to make some, not groundless, Estimate of their Differences. This is done by a hollow Cylinder of Brass, or other Metal, made somewhat heavy at the bottom to make it swim upright, that sinks more, or less in several Liquors, as they are lighter, or heavier, one than another. But the diligent *Mersennus* himself, who proposes this Way, confesses it to be very difficult to make sure Observations by it. To which, I shall therefore add but this, that, being a Metal, it may be corroded by Acid *Menstruums*, and if it be of Brass, or Copper, it may be wrought upon or injur'd by Urinous *Menstruums*, too.

What *Mersennus* said of this Instrument, may be applied to another, tho' differing from it, both in Shape and Matter. For 'tis made of

two

two Glass Bubbles, and a very slender Stem, which is Hermetically Sealed with a Ballast in the lowermost of Quick-silver, to keep it steady, when partly immerst in Liquors, in which this Instrument, like the Metalline Cylinder, sinks deeper in lighter Liquors, than in heavier, in a measure somewhat answerable to their Differences in Gravity. But, tho' I have, on several occasions, employed these Instruments, and found them not unuseful, when I did not confine my self to One, or Two, but made use of several of different Sizes, according to the various Liquors, I was to examine; yet what you may elsewhere find about this Instrument, dispenses me from saying any more of it in this place, than that, for some of the ends aimed at in this Chapter, it is inferior to the Way of examining Liquors by the help of the Ballance.

There is also another Way, that is Hydrostatical, proposed by *Merfennus*, of weighing of Liquors in

Water, and it is This; He bids you take a Glass Vial, to which, being first weighed in Air, and then in Water, you are to adjust a Stopple of Wax, or Cork, that will fit it exactly. This done, you are to fill the Vial with the Liquor you would examine, so that no Air be left between it, and the Stopple. The Vessel thus filled, you are to weigh in Water, and substract from its Weight there, the formerly noted Weight of the Glass it self in Water, and also That of the Stopple; which done, the remains will give the Weight of the Liquor proposed in Water. This Method, I lately chanced to find propounded by (the Writer newly nam'd) the industrious *Mersennus* in his *Hydraulicks*; but, I remember not, that he affirms himself to have made use of it; And tho' it may be serviceable on some occasions, yet, I fear, it will be troublesome in Practice. For, (to omit some inconvenient Circumstances) ordinary Vials, capable of containing

containing a competent Quantity of Liquor, are, usually, too heavy to be employed with tender Ballances; and common Stopples (such as *Mersennus* may be well supposed to have employed) will be subject to divers inconveniencies; as, that they may be penetrated by some Liquors, and corroded by others, and if they be made of Cork, or of common Wax, or any other Substance lighter, *in Specie*, than Water, 'twill not be easie to find its specifick Gravity; especially since Evaporation, and other Accidents make this it self vary; and whatever Matter, Vegetable or Animal, it be made of, the Vessel will cost you two Operations, One to discover the Weight of the *Vessel* in Water, and the Other that of the *Stopple*, (at that time) which is troublesome. Wherefore, when I met with this Way in the ingenious *Mersennus*, it seemed to me more inconvenient, than One, that, I remember, I had formerly thought of, and which I have sometimes put in Practice, by  
 choosing

chusing a Vial not too large, and of a round Figure, that being the most capacious under such a Superficies, and, instead of other Stopples, fitting it with one of (the like) Glass, carefully ground to the Neck of it. For, by this means, the inconveniencies of a Stopple lighter than Water were avoided, nor would the Stopple alter its specifick Gravity, either by Imbibition, or Evaporation, nor would it be penetrated by the most subtil Spirits, nor corroded by the most fretting Ones. To which may be added, because, in some Cases, it may be considerable, that a Glass-stopple, as it will not be wrought on by the Liquor contained in the Vial, so it will not communicate any Tincture, or extraneous Quality, to the Liquor, which cannot be affirmed of a Stopple of Cork or Wax, in reference to some Subtil and very Corrosive, or otherwise very penetrating Liquors, this Hydrostatical Bot-tel (as for distinction sake I call it) being together with its Stopple carefully

fully weighed, First in Air, and then in Water, (that the Gravity of the whole Instrument in that Liquor may be settled once for all) we fill'd it exactly with the Liquor to be examined, and so proceeded, as we if were to weigh Quack-silver according to the Manner formerly declared in the Eighth Chapter. The Weight of the given Liquor in Water being thus obtained, its Proportion in Weight to Water of the same Bulk may be easily discovered by the Way formerly delivered in the Second Chapter (or the Tenth Chapter.) This way of examining Liquors may, on some occasions, do good Service, and I did the rather, now and then, make use of it, because 'tis applicable to all kind of Liquors, whether heavier *in Specie* than Water, or lighter.

If you lay aside the Stopple, the round Ball it self may be made use of, on several Occasions, instead of that Hydrostatical Bucket, formerly mentioned; for the weighing

of Quick-silver, and divers heavy Powders; especially if they be Course Ones. But if the Instrument be fitly shaped, and not too heavy, there may belong to it a greater Conveniency than This. For when you have, and are willing to spare, Liquor enough to inviron the little Bottle, it may be usefully substituted to the Hydrostatical Bubble, with Quick-silver inclosed, that I formerly recommended. For, by reason of its exact Stopple, it has no need of an Hermetick Seal, (which is not easie to be made or procured;) and 'tis far less Subject to be broken, than a Bubble. And yet that which I most made use of, (and which weighed about  $\text{ʒi ʒiiijss}$ . Grains  $\text{xix}$ , or 709 Grains) being well stoppt with only Air in it, would sink by its own Weight in Water, and in Liquors lighter than This, as Wine, Brandy, &c. And if it were to be employed in Liquors much more Ponderous than Water, as *Aqua Fortis*, Oil of *Tartar perdeliquium*, &c. 'twas easie  
to

to make it fit to be weighed in them also; by putting into it a Quantity of Quick-silver (or some other fit Body) of a determinate Weight, as two, three or four Drams, before we stopp'd it: Which Ballast, when the Operation is over, may, if it be Quick-silver, be easily taken totally out, and kept apart for the like Uses: and the empty Bottle, and Stopple, may thereby become fit again, to be weighed in Water and lighter Liquors.

But notwithstanding all this, because Glasses, for size, shape, and weight, fit for Ballances, tender enough, and furnish'd with Glass Stopples exactly fitted to them, are very difficult to procure; and the Way it self is subject to some of the Inconveniencies, that we imputed to other Ways, not long since mentioned: it seems, that, generally speaking, this Way of finding the Weight of Liquors in Water, is Inferiour for common use, to those more simple Ones, that we formerly recommend-  
ed.

*See the  
Chapter.*

CHAP.

## C H A P. XIII.

Use VI. **H**AVING now laid down the Method of weighing one Liquor in another, 'tis allowable, and may be fit, that we subjoyn some Application of it: Especially, because it will become me to make good, in some measure, what, I remember, I formerly hinted to you, *viz.* that, in the subsequent part of this Paper, there would be delivered a further Use, which may be counted the VIth. of the Hydrostaticks in examining Medicinal Bodies. And *tho'* by the Instances we lately had occasion to propose in some of the Chapters preceding This, divers things referable to this Use, are set down already; Yet I should not content my Self, (as I now must do) to point at the chief *Heads* or *Kinds* of things referable to it; if, on a Subject that is more fertile, than it seems,

want

want of leifure did not restrain me from descending to treat of the particular Instances, that belong to them.

Among the Services then, that the Hydrostaticks may do a sagacious Phyfician, I must not omit One, tho' it has not hitherto, that I know of, been propounded by any Author. And, I hope, you will not think it improper to be taken notice of here, tho' it do not regard *only* the *Materia Medica*, but is applicable (as I may elfewhere relate that I made it) to divers Subjects, that are referable to other Parts of Phyfiology: Since divers Bodies, that seem not fo directly to regard the *Materia Medica*, as 'tis usually repositied in the Shops of Drugfters, have been, in *some times and places*, and may deservedly be *now* made to afford Matter for Remedies, to a free and ingenious Phyfician.

I confider then, that there are many Liquors, whose specifick Gravity it may be useful to know, not only,  
as

it may help to distinguish Genuine, or well conditioned Ones, from Them that are not so, but for other good Purposes too.

Instances of this kind may be afforded by the Juices of Herbs and Fruits ; where (according to the Direction given in the last Chapter) we first weigh a determinate Quantity, as an Ounce, or so many Drams, in our Hydrostatical Jar, or Bucket ; and putting some Oil of *Turpentine* on it, we sink it warily into that Liquor ; whose specifick Gravity in reference to refined Silver, clear Rock Chrystal, (or some other Body, if we know it to be as pure) has been *carefully* found out and registred : For, by this means, (as we have lately manifested) substituting this Oil for common Water, we may discover the specifick Gravity of Liquors, not to be weighed in Water, because they mingle with it. And thus we may find, not only the difference in Ponderosity between the Juices of  
Plants

Plants of differing kinds, as of Wormwood and Roses, and sometimes of the subordinate *Species* of the same *Genus*, as of *Absynthium Vulgare*, *Ponticum*, *Romanum*, &c. and Roses *White*, *Red*, *Damask*, *Yellow*, &c. but we may on some occasions observe, whether, and, if at all, how far, the keeping of a Juice for some time, more or less, or the Fermentation of it, or the Putrefaction, will alter its specifick Gravity. There are also other Liquids us'd by Physicians, and not ponderable in Water, that may be by this Way examin'd, as Honey, Vinegar, Verjuice, &c. And by the same Way may be also discovered and compared, the specifick Weight of the Juices of Fruits of different kinds, as of Grapes, Apples, Pears, Quinces, &c. and of subordinate *Species* belonging to the same *Genus*; as the newly expressed Juices, that make Sacks, French-wines, Rhenish-wines, &c. and those Liquors, that are pressed out of several sorts of

H

Apples,

Apples, as Pippins, Pear-mains, John-Apples, Queen-Apples, &c. And in divers of these, a Person that is curious enough, may probably, by the Method we have been proposing, be enabled to take Notice of the Differences produced in the specifick Gravity (whose Changes are usually accompanied with those of Consistence, &c.) in the several successive States, wherein the Liquors may be found at different times; as (not to mention the Juice of unripe Grapes, *viz.* *Krjuice*) the Juice of ripe Grapes is in very differing States, *when* 'tis newly pressed out; *when* it begins to ferment; *when* 'tis yet but New Wine; *when* it has attain'd its full Maturity and Perfection; *when* it begins to degenerate into Ropy, prick'd Wine, &c. and *when* 'tis absolutely changed into Vinegar, or else into *Vappa*.

But here it ought not to be concealed from you, That in this kind of Experiments, to make use successfully of the Hydrostatical Bucket

is a Task difficult enough, for Reasons that a few Tryals will easily discover. And therefore, tho' I would not discourage the Skilful, yet for those that do not find themselves dextrous at making Experiments, I think it adviseable to imploy, instead of the Bucket, Amber, or some other convenient Hydrostatical Solid, or rather (which is better) a Glass-bottle and Stopple, such as We formerly described; but as large, as may well be imploy'd without over-loading, or injuring, the Balance.

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#### CHAP. XIV.

**A**S I thought 'twas fit to give the foregoing Advertisement, by way of Caution, in the Cases that occasioned it; so having considered the Nature and Scope of the Hydrostatical Experiments in General, that belong to this Essay; I shall venture

to add for the Encouragement of those, that are better furnished with inquisitive Minds, than with nice Ballances ; that *tho'* in divers Tryals, especially Those that are made about precious things, as Gold, Pearls, Diamonds and other Gems; there is no relying upon any, but very Good and tender Ballances ; Yet, on many other occasions, 'tis not necessary, *tho'* it be desirable, that the Scales, we employ, should be extraordinary Good. And this for two Reasons: *First*, because many Hydrostatical Experiments are such, that a little Variation from the exact Proportion of the Solid to the Liquor, or between Bodies of the same Denomination, can lead us into no considerable Error ; or, at least, not defeat the Experimenters main Design ; as, with a Ballance that is not nice, One may sufficiently distinguish between an human *Calculus*, and a Pebble, or other ordinary Stone ; and between Course and Fine, native *Cinnamon* : And between a true Guinea,

or other piece of coyned Gold, that is not very small, and a counterfeit One, of Brass, or any such mixture, tho' never so finely guilt.

And *Secondly*, Because, *as* there are few Physical Experiments, wherein Mathematical Preciseness is necessary, and fewer wherein 'tis to be expected; So in many Hydrostatical Tryals, 'tis very probable, that the difference of Bodies of the same kind, or Denomination, flowing from their Compositions, and internal Textures, will make a discernable, tho' but small, difference in their specifick Gravity: As, in Rock-Chrystal it self, we have found some pieces to be to Water, as 2  $\frac{1}{2}$ , or a little more, to One; and others, to be to the same Liquor, as Two and Six, or between Six and Seven Tenths to One. And therefore, how exact soever the Ballance be, there must be some Allowance made for the diversity, that may be found in the Bodies themselves, that are examined, which diversity may perhaps

produce, at least, as great a Difference in the Proportions we seek for, as needs to be expected from a small Difference of tenderness, in the Ballances we imploy. And indeed, neither One of those Differences, nor the Other, (nor perhaps Both together,) is wont to be so considerable, as to challenge much regard in Physical Experiments; or at least, as to hinder it to be true, that, on most occasions, the Hydrostatical Way of examining the specifick Weight of Bodies, is preferable by far to any other Way of doing it, that has been Practised.

Before I proceed to the remaining part of this Essay, it will be worth while to obviate an Objection, that I foresee may be made by Critical Naturalists, against the Method hitherto deliver'd, of finding the Proportion in Weight, betwixt a sinking Body, and Water of the same Bulk. For it speciously may, and probably will, be objected, that, by this Method, we cannot discover the

the Proportion between a Solid Body, and Water in General; but only betwixt the proposed Body, and the particular Water 'tis weigh'd in; because there may be a great Disparity between Liquors that are call'd, and that deservedly, common Water. And some Travellers tell us from the Press, that the Water of an Eastern River, which, if I mistake not, is *Ganges*, is by a Fifth part lighter than our Water.

But to this plausible Objection, I have Two things to Answer.

And *First*, having had, upon several occasions, the Opportunity, as well as Curiosity, to examine the Weight of divers Waters, some of them taken up in Places very distant from one another; I found the difference between their specifick Gravities far less, than almost any Body would expect. And if I be not much deceived by my Memory, (which I must have recourse to, because I have not by me the Notes I took of those Tryals) the difference between

VVaters, where One would expect a notable Disparity, was but about the Thousandth part (and sometimes perchance very far less) of the VVeight of either. Nor did I find any Difference considerable, in reference to our Question, between the VVeight of divers VVaters of differing kinds, as Spring-water, River-water, Rain-water, and Snow-water, tho' this last were somewhat lighter, than any of the rest. And having had the Curiosity to procure some VVater brought into *England*, if I much mis-remember not, from the River *Ganges* it self; I found it very little, if at all lighter, than some of our common VVaters.

And now I shall represent in the *Second* place, that I do not pretend, (and indeed 'tis not necessary) that the Proportion, obtainable by our Method, should have a Mathematical Preciseness. For in Experiments where we are to deal with gross Matter, and to imploy about it material Instruments; 'tis sufficient to have

have a Physical, and almost impos-  
sible to obtain (unless sometimes  
by Accident) a Mathematical Exact-  
ness; as they will scarce deny, that  
have, as I have done, considered, and  
made Tryal of the Difficulties, that  
oppose the Attainment of such a  
Preciseness.

ADDITIONAL ALPHABETICALLY

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CHAPTER

**CHAP. XV.**  
*Hydrostatical Stereometry,*

Applied to the  
**MATERIA MEDICA.**

**S E C T. I.**

**T**Here is an Use of Hydrostatics, which tho' it do not *directly* tend to the *Examen* of Drugs, or Simples received into the *Materia Medica*, yet may be Serviceable both to the Physician and the Naturalists, in delivering their Descriptions; and so it may *indirectly* conduce to the knowledge of them; and help, on some occasions, to distinguish between Genuine Simples (especially Fruits) and those that are not so;

¶ It is

'Tis known, that the Writers of the *Materia Medica* are wont to set down the Bigness of the Bodies they describe, by very uncertain Guesse; and those that, to be more accurate, assign them determinate Measures, are wont to do it, by saying, that such a Fruit, or other Body, is, for Example, an Inch, or two Inches, or half a Foot long; and half an Inch, or a whole Inch, or two Inches and an half, in breadth. But 'tis obvious to those that are not great Strangers to the Mathematicks, that, according to this Way of describing Bodies, there may be, by reason of the great Variety of Figures, especially irregular Ones, they are capable of, a very great Disparity of Magnitude, or Bulk, in Bodies, to each of which, the same Length and Breadth may belong or be applied.

I should here be able to present you an Hydrostatical Way of determining the Bulk of Bodies, both much nearer the Truth, than that  
newly

newly recited, and grounded as well on Experiments as Mathematicks : if among other Papers, I had not unfortunately lost One, that I wrote many years ago, about *the measuring of Solids, by the help of Liquors.* But tho' I cannot, out of my Memory, recover the *Theoretical* part of that Writing, (whose Loss I regret, because it had been examined by One of the exactest, as well as famousst, Mathematicians of our Age, whom I invited to be present at the chief Experiments ) yet, I think, I can call to mind as much of the *Practical* Applications of it, as may suffice for my present purpose.

The ground of the Way, I am about to propose to you, will be easily understood by the following, tho' but short, Account. I caused to be carefully made by skilful Artificers several Cubes, both of different Sizes and different Materials, as Marble and Metal ; whose sides were each of them, as near as the Artist could make them, either an exact Inch, or precisely more Inches than  
One,

One, according to our *Engliff* measure; which is said to differ very little from the correspondent One of the old *Romans*. These Cubes were carefully weighed in trusty Ballances: First, in the Air, and then in common Water. And tho' I found some little (and but little) difference, between the Products of the Tryals; yet that Difference being no more than might reasonably be expected from the scarce avoidable Imperfection, even of good Artists and their Tools; We concluded, that One might, without any considerable Error, take a *Medium* (as they speak,) between these Products, and allow even to this *Medium*, a Latitude of some Grains; since that Latitude will not amount to the Sixtieth part of the Weight of a Cubical Inch of Water. Since therefore some of our Tryals inclin'd us to judge, that about Two hundred and sixty; and some others to think, that about Two hundred fifty two; and others again, that about Two hundred

dred fifty six, came nearest to the true Weight of a Cubical Inch of Water; we thought our selves at liberty to make use of that Number, that should appear most commodious for Practice, by reason of its Divisions and Subdivisions into *Aliquote* Parts; Especially if the Body to be examined were not great; since, in that Case, Two or three Grains more or less would not be considerable, especially in a Physical Experiment, where Geometrical exactness is not to be expected, nor indeed required; and a far less accurate Estimate will be less inaccurate, than can with any certainty be made by the formerly mentioned Way of judging, by the Length, Breadth, and Depth (or Thickness) of the Body proposed.

I made the less Scruple to pitch upon the last of the Three forementioned Numbers of Grains, *not only*, because it affords many *Aliquote* parts for a Number that is no greater, since barely by a successive Bipartition

tion, it affords Seven such Parts, viz. 128. 64. 32. 16. 8. 4. and 2; But, because I was encouraged by an Experiment differing from those already mentioned. For, having caused to be purposely made by a good Artift, an hollow Cube of Brass, whose Cavity was fitted to contain a just Cubical Inch of Matter; (either Solid or Liquid,) we put it into one Scale of a tender Ballance, with a just Counterpoize in the other, and placed it there, as Horizontally as we could. Then we warily put into it, little by little, as much common Water, as it would contain, without either overflowing, or having its Surface, manifestly turgid; putting also from time to time in the opposite Scale, small Weights to keep it from swerving too much at once from an *Equilibrium*. And tho' it is extremely difficult in Practice, to discern with certainty, when the Vessel is so exactly filled, that a Drop, or even Two, or Three drops, more or less, cannot be added, or taken away,

way, without being observable by the Eye; Yet, for this very Reason, we thought our Experiment agreeable enough to our Supposition, when we found, that by so light an Alteration, the Weight of the Water, when the Scales were heedfully Counterpoized, amounted to near about Two hundred fifty six Grains, which Number we shall therefore hereafter imploy, as expressing the Weight of a Cubical Inch of Water.

And now to apply the past Discourse to our present Purpose.

Suppose, for Example, that a Solid, heavier *in Specie* than Water, having been weighed first in the Air, be found to lose of its Weight in the Water  $\frac{3}{8}$  Sixteen Grains, that is, Two hundred fifty six Grains; I say, that the Dimensions of this Solid, if it were of a Cubical shape, would make it equal to a Cubical Inch: So that, (to express the thing yet more clearly,) if the given Body be supposed to be an easily fusible Metal,

Metal, as Tin, or Lead; and being melted to be warily poured into the hollow Cube formerly mentioned, and suffered to cool; it would just fill it and no more; and consequently be a Cube of Metal, whose Length, Breadth and Depth are equal to one another, and each of them to an Inch. For, as 'tis a Fundamental *Theorem* in Hydrostaticks, demonstrated Mathematically by *Archimedes*, and else where Physically by me; that a sinking Solid weighs lesse in Water than in Air, by the Weight of as much Water as is equal to the Solid in Bulk; and since we have lately shewn by Experiments, that a Cubical Inch of Water weighs 3*ss*. 16. Grains, that is, 256 Grains; it will follow, that when the Decrement of a Bodies weight in Water is found to be 256 Grains, the Solid content of that Body is a Cubical Inch: Since an *Aqueous* Body weighing 256 Grains is equal in Magnitude, as well to

the Solid propounded, as to a Cubick Inch of Water. And here it may prevent a Scruple, to observe, that, to make Bodies equal in Magnitude, it is not at all necessary, that they should be of the same Weight, or of the same Matter; as is evident in Bullets of Copper, Tin and Gold, cast separately and dextrously in the same Mould. For tho' they be equal in Bulk, yet the Bullet of Copper will be much heavier than that of Tin; and the Bullet of pure Gold will be more than twice as heavy, as that of Copper. Whenever therefore you meet with a Solid, ponderous enough to sink in Water, that being weighed in that Liquor loses 276 Grains of the Weight it had in the Air; you may conclude, the Magnitude or Bulk of that Body to be equal to a Cubical Inch; of whatever Matter it consists, or of what Shape soever, regular or irregular, it be. And in case the Solid proposed do sink it will very often happen

happen) lose of its Weight in the Water less than 256 Grains; you may conclude its Bulk to be proportionably less than a Cubical Inch. And such is the Conveniency of the Number we have pitch'd upon, which abounds in *Aliquote* parts; that every 32 Grains, that the Solid loses of its Weight in the Water, answers to an Eighth (that is, half a Quarter) of an Inch in the Bulk of the Body: as, if the Decrement be 128 Grains, the Solid will be half a Cubick Inch; and if it be but 64 Grains, 'twill be but a quarter of a Cubick Inch; and so if it be 160 Grains, 'twill be  $\frac{5}{4}$ , that is, half and half a quarter of an Inch Cube: and on the other side, if the Decrement of the given Body exceed the Standard, *viz.* 256 Grains, twice, thrice, &c. then that Decrement being reduced to Grains, as suppose it weigh 31 + Grains 32 (amounting to 512 Grains;) or 31 8 + Grains 48 (amounting to 768 Grains) the Body will be equal

to two or three (single) Cubical Inches. And if, after the Division there remains a Fraction, 'twill not be difficult to estimate it, to him that considers what has been newly delivered.

## S E C T. II.

**T**O discover Hydrostatically the Solid Contents of a Body heavier *in Specie than Water*; to him that knows how to make use of the Method newly delivered, 'twill not not be very difficult. But to measure, by the help of Water, the Solidity of a Body lighter *in Specie*, than that Liquor; is a work not so easily performed. It may somewhat lessen the Difficulty, to premise, that there are two sorts of Bodies, that will naturally not sink in Water. For *some* are of a closer Texture, and will

will not be easily invaded by that Liquor; at least, in so short a time, as they are of necessity to be kept in it: and *others* abound with Pores, that dispose them to imbibe the Water, they must be kept immersed in, till the Experiment be dispatched.

To begin with the First sort of Bodies: 'Tis known to Hydrostaticians, that, according to a *Theorem* of *Archimedes*, the weight of a Body belonging to that kind, may be gathered from the weight of the Water, that is equal, in Magnitude, to that part of the Body, that is immerst in that Liquor, when the Solid floats freely upon it; as, if a *Paralelipipedon*, or a *Cylinder*, of Wood, 12 Inches long, being placed upon Water, should rest there, when a 12th part of it lyes beneath the Surface of the Liquor; in this case, the Weight of the Water, equal in Bulk to that immerst 12th part, would be equal to the weight of the whole wooden Body. But because the Bodies, whose Bulk Physi-

sion to Examine, will very seldom happen to have Shapes so near those of regular Ones; 'twill scarce be worth our while to enlarge upon this Way of Estimating light Bodies; which 'twill be so troublesome to make fit for most Mens Practice, that, unless it be desired, I shall not trouble you with it; but forthwith proceed to what will conduce far more to our present Design, which being, *To measure the Solid Contents of Bodies, not so heavy (intensively) as Water, and for the most part irregularly shap'd*; It will be necessary, that we imploy a Method differing from what we have hitherto made use of. In the First step of this, tho' not in the Second, we may be helped by the industrious *Mersennus*: Who probably borrowed his Way of *Ghetaldus*, from whose *Promotus Archimedes*, he professedly borrows many things.

But because, that, on this occasion, *Mersennus*, affecting Brevity, hath made himself obscure; so that what he

he writes can scarce be understood, but by Mathematical Perusers; I shall, for the sake of another sort of Readers, deliver the propounded Method, tho' not in so few words, yet more clearly, and orderly: *First* then, you shall weigh in the Air, the Body, (lighter than Water) to be examined: *Secondly*, you shall take a Plate of Lead capable of making this Body sink with its self in Water, and of some Weight not incumbered with Fractions, as just a Dram, half an Ounce, an Ounce, &c. *Thirdly*, you must weigh this Plate in Water, and by subtracting its Weight in this Liquor, from what it weigh'd in the Air, you must obtain a Difference, which will give the weight of as much Water, as is equal in Bulk to the immersed Lead. This, for distinctions sake, may be called, *The specifick Weight of the Lead in Water.* *Fourthly*, you must tye together (which you may best do by One or more Horse-hairs,) the Plate of Lead, and the lighter Body, and

note the Weight of the Aggregate ; which, as you know, is nothing but the Sum of the respective Weights of the lighter, and of the heavier, Body. *Fifthly*, you must weigh this Aggregate in the Water, and subtract its Weight in that Liquor, from the Weight that the same Aggregate had in the Air ; and the Difference will be the Specifick Weight of the said Aggregate in Water. *Sixthly*, From this Difference, subtract the formerly found *Specifick Weight of the Plate alone in Water*, and the Remains will give you the Weight of the lighter Body in the same Liquor.

Thus far our Author ; without whose help, we may easily dispatch the rest of our Work, by the Method employed already of measuring Solids heavier than Water. For the lately obtained Weight of the light Body in Water, being, (according to the Method formerly proposed,) divided by 256 Grains, will give you the Solid content of that naturally floating Body, But

But because a Method, that is difficult enough to be put in Practice by those that are not more than ordinarily well versed in Hydrostaticks, requires to be illustrated by an Example; I shall subjoyn an Experiment, that may serve, not only to clear up this Practice, but, in good measure, to confirm it too; We took then a piece of Oak conveniently shaped, and that weigh'd in Air,  $193\frac{1}{2}$  Grains. To this we tyed with an Horse-hair, a Plate of Lead weighing just half an Ounce, *i. e.* 240 Grains. But before we tyed them together, the Lead was weighed in Water, where it lost of its former Weight 20 Grains, which, being deducted out of the 240 Grains lately mentioned, left a Difference or residue of 20 Grains, for the Specifick Weight of this piece of Lead, (For I have seldom found Lead quite so heavy) in the Water. Then the Aggregate of the Wood and Lead was weighed; First, in the Air, and found to be 433 Grains and an half, and Then in Water,

Water, where it amounted but to 162 Grains; which being subtracted from the Aggregate of the same Bodies in the Air, the Residue, or Difference, was found to be 27  $\frac{1}{2}$  and  $\frac{1}{2}$  Grains: From which Difference, the other Difference of 20 Grains (which had been lately found) of the Leaden Plate alone in the Water, being deducted; there remained 25  $\frac{1}{2}$  Grains and  $\frac{1}{2}$  for the Weight of Water equal in Bulk to the given piece of Wood. If this number had amounted to 256 Grains, of which it fell short but 4  $\frac{1}{2}$  Grains, we might have concluded the Solidity of it to be a Cubick Inch; since 256 Grains of Water, which we formerly found equal to a Bulk of Water of a Cubick Inch, was also now found equal to the Bulk of the given piece of Wood. And indeed, intending (as I formerly intimated) to give an Example, that should not only Illustrate, but Confirm, the proposed Practice; I caused the Wood I employed to be formed into as exact a Cube of an Inch

Inch every way, as I could procure from a Joyner, that bragged of the Pains he had taken about it: So that the Difference of its Weight in Water from 256 Grains, the Weight of a full Cubick Inch of that Liquor, may probably be imputed to some little Imperfection in the Figure of the Wood, or some other light Circumstance, not considerable enough to be much regarded,

*Of this Experiment one of my Notes gives the following Account.*

I. The Oaken Cube in Air } 193½.  
weighs (3iii Grains xiii.)

II. The Weight of the Lead } 240.  
in Air, (3iv.)

III. The Weight of the Lead } 220.  
in Water (3iiß Grains x.)  
which, being subtracted from  
its Weight in Air, leaves for  
its Specifick Weight in Water } 020.

IV. The Aggregate of the } 433½.  
Two in Air is

V. The

V. The weight of both together in Water, is— } 162.  
 Which being subſtracted from its Weight in Air, gives the Difference of both the Ag- } 271½.  
 gregates,

VI. The Difference between the weight of Lead alone in Air, and in Water, or which is all one, the Specifick weight of the Plate alone, viz. } 2020.  
 being ſubſtracted from the Difference of the weights of the } 251½.  
 Aggregates in Air, and in Water, gives [for the weight of the Cube propoſ'd,]

The Way of meaſuring Bodies, that has been hitherto delivered, is appropriated to ſuch, as will not at all, or, at leaſt, will not readily, be diſſolved in Water. But becauſe there are divers other Solids, as Lumps of *Salt, Alum, Vitriol, Sugar, &c.* whole Magnitudes it may be fit for inquiſitive Men, of more Professions than One, to know, and to compare; I ſhall to what has been already

already said, subjoyn this Advertisement; That the same Way may be applyed to measure the Magnitudes of Solids dissoluble in Water, if, instead of this Liquor, we substitute Oil of Turpentine; whose Proportion, and Specifick Gravity to Water, we have found, or is otherwise known to us. When I first made this Reflection, I had not such Conveniencies, as when I found the weight of a Cubick Inch of Water, to determine the weight of a Cubick Inch of Oil of Turpentine. But, having yet lying by me the hollow Vessel of Brass, whose Cavity was an exact Inch, that I imploy'd to find out the weight of a Cubick Inch of Water; I made use of it on this occasion too: and found that, when it was carefully filled with such Oil of Turpentine, as we were wont to imploy about Hydrostatical Experiments; the contained Liquor amounted but to 221 Grains, and an Eighth (part of a Grain;) by which number the Difference of the weight of  
of

of a Solid in the Air, and in that Oil, being divided, the Quotient will give you the Solid Contents of the examined Body.

After so circumstantial an Account, as we have given, of the Way of Hydrostatically examining such floating Solids, as, like the Wood we imploy'd, are of a Texture at least *moderately close*; it may be seasonable, to proceed to the mention of the Second sort of floating Bodies, that I formerly told you, might be propos'd to be weigh'd in Water: Namely, such as, by their Porosity or *Laxeness of Texture*, are subject to imbibe too much of that Liquor; even in as little time as is necessary for the dispatch of the Experiment.

In his  
Phænomena Hydro-  
raulica,  
pag. 185.

Mr. Merfennus (more briefly & than clearly) proposes an Expedient in this case, which is to cover over the Body to be weigh'd in Water with Wax, Pitch, or some other Gluten, as he calls it, whose Specifick Weight in Water must be first known. But,

I take Bees-wax to be much preferable, to the other Two. For Pitch is so apt to stick to Ones Hands or Cloathes, that 'tis troublesome to apply it, and very difficult to get it off. And as for Glues, most of them, especially the more common, are dissoluble in Water, and therefore not so fit for the purpose as Bees-wax, (for That, I presume, he means by Wax,) which has this Conveniency in it, that its Proportion to Water being usually constant enough, and the Gravity of those two Bodies differing but little, one may more easily dispatch a good part of the Experiment; which is thus to be performed. Take the Solid (lighter than Water, that you would examine Hydrostatically, and having weigh'd it in the Air, over-lay it carefully with a thin Coat of Bees-wax, so that no part of it may remain uncovered, or accessible to the Liquor. Then take also in the Air the Weight of the Wax you have imploy'd, and fasten to the Body  
thus

thus coated, a Plate of Lead, or Tin, heavy enough to make it sink, and observe the weight of the Aggregate in Water. This done, subtract the weight of as much Water, as is equal in Bulk to the Wax, and proceed with the rest, as is before taught. *Mersennus* declares this Practice by this Instance, if the Wax that invests the proposed Body be of  $\text{xxxij}$  in the Air, the Bulk of Water equal to it will be  $\text{xxxi}$ ; and therefore a Quantity of Water of  $\text{xxxi}$ , must be first taken away, or subtracted, that the remaining Bulk, equal to the (immerst) Body, may, by its Gravity, shew the Gravity of the Body (proposed,) as has before been said.

But, because the Way, above delivered, can help us but to the knowledge of the *Weight* of the proposed Body in Water; we must, to discover the *Solid Content* of it, proceed further than our *Mersennus* enables us to goe; and therefore we must divide the Weight of the Solid in Water, already found, by 256  
Grains,

Grains, that by the help of the Quotient we may obtain the Solid Contents of the proposed Body.

I have sometimes (to add That upon the By,) thought of, and try'd, another Expedient, to hinder smaller Solids, whether lighter or heavier *in Specie* than Water, from imbibing the Ambient Liquor. In order to this, I *first* found the Weight of a Cubick Inch of Quicksilver, (which is not difficult to discover by its Proportion to Water of the same Bulk.) And *then* we brought the Body to be measured, into a Vessel, whose Solid Contents were known before; and *Thirdly*, all that was not possessed by the firm Body, being filled with Quicksilver, 'twas easie enough to know by the Difference in Weight of That Quicksilver, from the Weight of the Quicksilver, requisite to fill the whole Vessel, to how much Quicksilver the environ'd Body was equal. And by this means, and the knowledge before gained of the Weight of a Cubical Inch of

K      Mercury,

Mercury, the Solid Contents of the Body proposed, was not difficult to be obtained. But I forbear to give more than this Intimation of an Expedient, which, besides that it belongs properly to another Essay, is rather Mechanical than Hydrostatical. And for the same reason, I forbear to set down one Way of measuring the Contents of Irregular Solids, delivered in some Books of Practical Geometry; and another, but yet unpublished, Way, differing enough from the Former, that tends to the same purpose.

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### C H A P. XVI.

**B**Ut, I perceive, that 'tis now more than time, that I should put an end to a Labour, that has, I fear, tyr'd you, because, I am sure, it has tyr'd me. And yet I dare not conclude this Tract without briefly answering a couple of Questions,

Questions, that, I foresee, may justly enough be asked me by a Peruser of the foregoing Essay.

And *first*, I presume it may be demanded, *Whether I have proposed the best Ways that can be thought of, to examine Bodies Hydrostatically?* To which Question I answer, that, upon divers Considerations, some of which have been mentioned here and there in the Body of the foregoing Essay, I did not think my self obliged solicitously to Invent, or propound, new Instruments for the Hydrostatical *Examen* of Bodies. For *tho'* I am not Ignorant, that divers more curious and Artificial ways of finding out their Weight in Water, or their Solid Contents by it, may be devised by Persons more skilful and sagacious than I. And *tho'* also I think it not unlikely, that, when the Utility of such Practices comes to be taken notice of, Artificial Instruments will be found out to Facilitate, or otherwise Improve them: Yet, I thought it became me at first to propound

only the more simple Ways of Operating, as the most likely to invite the Generality of those, for whose sake this Essay is made publick; and to require, for the main part of our Experiments, only the Use of the Balance, as an Instrument easily procurable, and already, for other purposes, in most Mens hands, without mentioning, at this time, any more Artificial Instruments; tho' some of them are such, as I have long since not only had thoughts of, but, for my own Uses, practis'd; which Intimation may be countenanced, if it were needful, by the mention of that little Instrument, for distinguishing between true and counterfeit Guineas; or the like Pieces of coyn'd Gold, by the help of Water; which was several Years ago published in the Philosophical Transactions, and has since (without staying for my Improvements of it) been made Use of by Some, and usurp'd by Others. But of such things, no more in this place.

Having

Having answered the First Question, it remains, that I consider the Second, wherein tho' I shall aim at Brevity as much, as in the former, yet I fear, I shall not be able to discuss it in as few Lines, as I did That. I presume then, it will be asked, *What Credit may be given to the Estimates of the Weight, and Proportions of Bodies, obtained by Hydrostatical Tryals?* Since, we see, that tho' Mathematicians, not knowing, or not applying, our Observation about the Specifick Gravity of Rock-Chrystal, and the Nature of Oil, especially that of Turpentine, have given us but the Proportions of Metals, and some very few other Familiar Bodies, as the Loadstone, Wax, Honey, Oil and Wine; yet those few that have not transcrib'd from one another, differ in the Tables, they have left us, of the Comparative weight of those few Bodies.

This Question is so comprehensive, that, I think, it cannot well re-

ceive a single Answer ; and therefore, I shall offer Two things to be considered about it.

And *first*, I freely acknowledge, that there is no exact Uniformity in the Observations delivered about the weight of Metals, and the other Bodies newly nam'd, among the few Authors that have written of this Subject ; and there would probably have been yet more Difference in their Accounts, if some, even of those Writers, had not avowedly made use, to their purposes, of as much as they thought fit of the Tables of *Ghetaldus*.

Nay, I shall not think it very strange, if I find, that the Experiments of the same Man, made at distant times, and in other differing Circumstances, should not all of them exactly agree. For I have already noted, and, I think, in more places than One, that there will scarce be found so great an Uniformity in Qualities, and particularly in Specifick weight, among Bodies of the same

same Kind or Denomination, as there is generally presum'd to be. There may be also some Difference, tho' but little, betwixt the Waters Men employ, especially if the Air be at One time (as in *July*) intensely hot, and at Another (as in *January*) exceeding Cold. The Difference also of Degrees of Goodness of the Balances, Men employ about nice Experiments, is not altogether inconsiderable. But there is a thing of greater Moment than this, towards the hindering Hydrostatical Experiments, and even Statical Ones themselves, from being so accurate, as those, that are not versed in such Matters, may require. The thing I mean, is, the Difficulty of finding an exact Uniformity in Weights of the same Denomination, which, for that Reason, are vulgarly supposed to be exactly equal; But, to know how far this Supposition is to be rely'd on, it may at present suffice to set down some Passages of a Mathematician justly famous for his diligence,

In Præfatione ad  
Librum  
de Mensuris,  
pond-  
ribus &  
nummis.

gence, and who has made it his particular Work to examine these Matters scrupuolously. The first Passage, I shall allege out of his Writings, shall be the short Account he gives of many Tryals he made of natural Grains, whence all sorts of weights have been deduced. *Cum* (saith he) *omnia grana, vel semina, qua reperiri solent in atriis venalibus Lutetia, ad Stateram expendissem, vixque granum ullum inter ejusdem speciei grana grano alteri exacte respondisset, in incertis ludere nolui.* The same Author informs us, that the Roman Grains differ from the French Grains; since, as, he observes, 688 Grains of the former sort, are Equiponderant but to 576 Grains of the later sort. And he subjoyns, that, whilst he was writing these things, there was found by the more exact weights of the Mint, an Error in the former Estimate, of at least half a Grain in 36 Grains.

And elsewhere he gives notice, that, by two Relations, sent him from Rome,

*Rome*, about the Number of Grains, contained in a *Roman Ounce*, it appear'd, that even that Number varied, since One of those Relations reckoned 612 Grains in an Ounce, whereas the other allowed it but 576 Grains. And yet this I do not wonder at, because I have my self found it so difficult in Practice, to get and keep Weights (for, as little as this is wont to be suspected, the the very Air may, in time, a little alter them,) as exact, as I desired, that I left off the hopes of it. And one Remark, tho' commonly overlooked, I think too considerable to be here omitted. For, whereas the accurate *Ghetaldus's* Tables of the Weight of Metals, and some few other Bodies, in reference to one another, are looked upon as the most Authentick that have been published & are accordingly made the most use of: 'Tis certain, that the Weights he employ'd are not divided, as Ours are. For, tho' indeed according to him,

*Merfennus in the Paper entituled, Parisiensia Pondera, Corollar. 1, and 2.*

*In the Paper called Galic. Nummis.*

as well as with us, the Ounce consists of Four and twenty Scruples; yet the Scruple, which with us is divided but into 20 Grains, he divides into 24. But to return to *Mersennus*, a while after he had told us of the Difference between his repeated Tryals, and Those of other Men, in determining the Weight of a certain Body, he has this Passage; which shews, that he was not over-confident of the Preciseness of all his own Determinations. *Cum autem* (saith he) *pag. 37. lib. 16. Dixi, Chelinum, undecim dici denariorum, credunt tamen alii decem duntaxat, nil assero.*

Having gone thorough the First part of my Answer, to the Second Query above proposed, it remains, that I proceed to the Other part; which perhaps will not need more than the following Reflection.

I consider then, that ~~tho'~~ it be granted, that Hydrostatical Experiments are not always either singly accurate, or exactly agreeable among them.

themselves; yet they may well be, both accurate enough to be of very good Use, especially in Practice; and less remote from being quite accurate, than any other Ways that have been hitherto known to be Practised, of determining the Proportions of Bodies in point of Weight and Bulk, and of measuring the Solid Contents of stable Bodies, whether heavier *in Specie* than Water, or lighter.

The *First* part of this Reflection may be deduced, as a Corollary *from*, or at least confirmed *by*, the greatest part of the foregoing Essay. And indeed, as little Skill as I have in Hydrostaticks, I would not be debarred from the Use of them, for a considerable Sum of Money; it having already done me acceptable Service, and on far more occasions, than I my self at first expected; especially in the *Examen* of Metals and Mineral Bodies, and of several Chymical Productions. And I have been able  
more

more than once or twice, to deceive Artists and other Experimenters, that, *bona fide*, believed they had made, or were Possessors of, *Luna fixa*, (as they call it) and other valuable things : And to make a good Judgment of the Genuineness or Falsity, and the Degrees of Worth, or Strength, in their kind, of divers richer or poorer Metalline Mixtures, and other Bodies, (some Solid, and some Liquid,) whose fair Appearances might otherwise have much puzzled, if not deceived, me.

But of This more may be found in another Paper. For I must hasten to the *Second* part of our designed Reflection, by representing, That our Hydrostatical Methods of discovering the Weights and Bulks of Bodies, tho' they be not Mathematically accurate, yet they are less remote from being so, than any Way of Mensuration of Bodies, (especially such little Ones, as we usually have need to examine on the account

count of the *Materia Medica*,) by the Geometrical Instruments, that are hitherto known to be Practised; or, by the Way; whereby the *Tabula Coitionis & Expansionis Materia per Spatia in Tangibilibus, &c.* was framed by the renowned Sir *Francis Bacon*; whose judicious Reflections upon the Rarity and Density of Bodies, such as their measures are delivered in that Table, do sufficiently manifest, as the Philosophical *Genius* of the Author, so the Utility that may be derived from even such Determinations of the Bulks and Weights of Bodies, as fall short enough of being accurate.

Verulam  
in Histo-  
ria denfi  
& rari, p.  
m. 8. &c.

I might here relate, that, to convince some curious Persons; how much Hydrostaticks may be made serviceable to as accurate Mensurations, as ought to be expected in Physical Experiments; I desired a *Virtuoso*, First, to put together two Lumps of Metal (*viz.* of Tin, and of Lead) in a certain Proportion, that

that he was to conceal from me, but to set down in Writing to prevent Mistakes. Then I desired him to melt the Metals (whose respective Specific Gravities I knew before) into one Mass, and give me that Mass. And Thirdly, I weigh'd it carefully in Water; and did also Algebraically examine it. Which being done, I told him, that the Lead, he had employ'd, amounted to such a Weight, and the Tin to such another; which being compared with the Quantities he had committed to Paper, the Difference was found to be little more than one Grain, and this it self probably proceeded from some scarce avoidable Imperfection in the melting, pouring out, &c. of the given Bodies. But because specious Arithmetick was employ'd in this Work, (to which, yet it was not absolutely necessary,) I shall lay no Stress upon it; because, if I mistake not, the past Discourse may suffice to give the Hydrostatical Ways, of Mensuration

furation of Bodies, a preference to their Competitors ; and may keep it from being presumptuous, to say, that they may be received as the best for Practice, till some other more accurate, and yet as firmly grounded, and as Practicable, Ways of accomplishing the same purposes, shall be propos'd.

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F I N I S.

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intention of bodies, a perfect  
their Comparisons; and may keep  
it from being prejudicial to the  
that they may be received as the best  
for instance, all some other more ac-  
curate and yet as finally rounded,  
and as Strickland, 1799, in  
filling the same purpose, shall be  
proposed.

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F I M 1 2

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A Previous  
Hydrostatical Way  
OF  
Estimating ORES.

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A PRACTICAL  
HYDROLOGICAL WAY  
OF  
ESTIMATING  
ORES.

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## Advertisements.

**I** Know there is a greater Number of different kinds of Fossiles, than Those that are yet known to belong to the Materia Medica. And, I confess, that the Persons, which the following Paper is chiefly designed to assist, are those that explore Minerals with an Aim not at Health, but at Profit. But yet I was content, that the ensuing Discourse should accompany the foregoing Essay, as a kind of Appendix to it, because many of the Subjects, about which both Tracts are conversant, are the same; and the Fundamental Observation, (viz. about the Specifick Gravity of Chrystal or Marble,) and the Hydrostatical Way of applying it, in Explorations, is the same

in both : and also, (and indeed, chiefly,) because I was made to believe, that it might, especially at this Season, be grateful, and not unuseful, to divers Searchers after profitable Minerals.

This Paper (as the Inscription intimates,) was designed to be sent to the Learned Secretary of the Royal Society; when it was expected, that he would begin again to publish Monthly the Philosophical Transactions, that had been long suspended, and as long desired by the Curious. But since some Accidents have occur'd, that occasion a further delay of their Publication, it was not thought fit, this Paper (after having been long already) should be any longer confin'd to my Closet. 'Tis true, that this Discourse, containing but an Application of an Hydrostatical Experiment; I am far, as I ought to be, from proposing it as a Treatise of the Docimastical Art; whose grand Instrument is, the Fire Skilfully manag'd. For which reason I have foreborn to set down in this  
 Paper,

*Paper, any of the Flux Powders, or other Ways of Examining Ores; or of Reducing Them, or other Fossiles, to Metals or Regulus's; that either Say-Masters are wont to employ, or I have devised, or try'd, upon Minerals. But, this notwithstanding, our unpractised Way of Estimating Ores, may not be useless; and for that reason, will not perhaps be unwelcome to some, that Love Mineralogy, much better than they Understand it: Especially coming forth at a time, when many industrious Persons of this Nation are excited to look after profitable Minerals, by the Repeal (that has been made, since our Appendix was written,) of a discouraging Act of Parliament, made in the Reign of Henry the IV. And tho' our Hydrostatical Way, of Estimating Fossiles, will not determine how Rich or Poor they are in this or that particular Metal; yet, (as is intimated at the beginning in the ensuing Paper,) it may, on many occasions, serve to keep*

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*those*

those that are *Venturous*, and not *Skilful*, from being deluded by *Cheats*, or from deluding themselves with ill-grounded *Expectations*; which the *Promising* appearances of divers *Fossiles*, especially *Marchasites*, will temptingly *Invite*, but never *Answer*.

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A Previous

Hydrostatical Way

OF

Estimating ORES.

*Address to the Secretary of the R. S.*

S E C T. I.

Sir,

**A**T a time, wherein so many ingenious, or industrious, Men appear very Sollicitous to discover and to work Mines, both Here and in *New England*, and Others of his Majesties *American Colonies*; it will not, probably, be thought unseasonable, nor prove un-

*A Way propos'd for the previous Examen of Ores.*

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welcome

come to the Seekers of Subterranean Treasures, if my desire to do them a piece of Service, make me borrow of a Paper, I long since wrote about some things relating to the *Materia Medica*, a few Paragraphs, that contain a Way of Exploration of Minerals ; which tho' it reaches but to One of their Qualities, will, perhaps, by reason of the Considerableness of of This, keep, on certain Occasions, some Searchers after Mines from beginning chargeable Works, or prosecuting them with too great Expectations, which are usually follow'd by proportionable Disappointments. And I make the less Scruple to suffer this Fragment to leave its Company, and present it self to you ; because, after the misfortune, I have formerly signified to you, of the Loss and Spoiling of several of my Writings, I know not when, if ever, I may have Opportunity of Communicating to my Friends the Treatise, that these Paragraphs belong to.

That

That Part of the forementioned Treatise, that concerns my present purpose, is founded on an Experiment, whereof what you are about to read, is One of the Applications.

I shall then succinctly inform you, that the Observation, whereon my Discourse was grounded, is double, as will by and by appear; and that the Rise of it, which will help to understand the Nature and Influences of it, was this. I thought fit, (for Reasons elsewhere given) to find out, what was the Specifick Gravity of a pure Stone, such as I supposed Chrystal or White Marble, or a Stony Isicle, to be; and found it by the Hydrostatical Way of Tryal, (doubtless not unknown to You,) that is delivered in the Essay called *Medicina Hydrostatica*, whereof when you please, you may command a sight, to have to clear common Water, equal to it in Bulk, or Magnitude, pretty near the *Ratio*, or Proportion of two and an half to one; or, which is somewhat more obvious

obvious to conceive, as five to two. I said, *pretty near*, because 'tis not always exact, nor need be for our present purpose, but usually enough does somewhat rather exceed that Proportion than fall short of it; but that is so little, that it may, on all common Occasions, be safely enough neglected by a Mineralist: Tho', if one pleases, one may make use of the Proportion of  $2\frac{1}{2}$  to 1, that is, of 11 to 4.

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## S E C T. II.

**T**He Uses, that may be made to our present purpose of this Fundamental Observation, are either of a more General, or of a more Particular, Nature.

As to the first of these; *When* my Intention is only to discover in general, Whether a Fossile propounded, or perhaps casually lighted on, may with probability be judged to contain

contain any Substance, either Metalline, or belonging to some Fossile of Affinity to a Metalline Nature; and also, Whether, in case the first Question be resolv'd in the Affirmative, the proposed Body does, indefinitely speaking, contain much, or but little, of the Metalline or other Adventitious Substance: *When*, I say, I would only make those General Inquiries, I weigh the Body I would examine, first in Air, and then in Water, and observe the Proportion in Specifick Gravity between them; and if I find it weigh either less, or but *little* more, than Chrystal or Marble of the same Bulk, I judge it unlikely to contain any Metalline Portion, considerable for its Quantity. And if it weigh manifestly, or somewhat *considerably*, more than Marble or Chrystal, I guess, that, in Proportion to that Excess, it abounds, more or less, with a Metalline Ingredient, or one or other of Affinity to a Metalline Nature.

To

To explain my self a little by two or three Examples; 'tis known, that the *Magnet* is vulgarly reckon'd amongst *Stones*, and its great Hardness confirms Men in that Opinion. But having observed, that Loadstones, especially those that come from some Places, that I elsewhere take notice of, seem to be *apparently* more ponderous than common *Stones* of the like Bulk; We weigh'd them in Air and Water, and found their Specifick Gravity, especially of some of them, so far to exceed That of Chrystal or Marble, that it could not be difficult for us to conclude, that these Fossiles contained a not inconsiderable Proportion of Metalline Matter, which, by Collateral Experiments, delivered in another Paper, appear'd to be of a Martial or Ferruginous Nature.

The Author means a Paper containing Experiments and Observations about the Loadstone, as 'tis a Mineral.

*Emeri* is a Fossile well known to many Tradesmen, especially *Armourers*, & *Gunsmiths*, by whom 'tis commonly reputed a mere Stone. But finding that its Weight in Water considerably

rably exceeded That of Chryſtal of the ſame Bulk, ſince it was to that Liquor very near, as 4 to 1; I conjectured, that it contained a Metalline Subſtance, as afterward, by proper Tryals, I found it to do. Upon the ſame ground, (its Weight in my hand) I concluded, that *Lapis Hematites*, that is commonly ſold in Shops, and, as its Name witneſſeth, paſſes for a Stone, did not ſparingly participate of a Metalline Ingredient; in proſecution of which Conjecture, I quickly thought on Ways whereby I diſcovered, that Iron or Steel was the Metal it contained.

And not to accumulate Inſtances in this place, I ſhall advertiſe you in general, (what perhaps may hereafter be found uſeful to ſeveral Enquirers) that, upon the Grounds hitherto mentioned, I was invited to gueſs, that divers Bodies, that were little ſuſpected to be of a Metalline, or Mineral, Nature, did really contain a Portion of Subſtance that was ſo. And, I remember, in particular, that,

that, having met with *Granats* of several sizes, that were not *Bohemian*, but were found in other Parts of *Europe*, and some that I discovered in a kind of *Talc*, that was brought me from *America*; which Angularly figured Stones, I suspected by their Weight to be Metallick, and found, by *Hydrostaticks*, to have a *Specifick Gravity* considerably surpassing That of *Chrystal*. Upon these Grounds, I say, I suppos'd them to participate, and that not very sparingly, of a Metal, one or more; and, by other Ways of exploring, found, that I had guessed aright; since I was able, notwithstanding the great Compactness of such seemingly vitreous Bodies, to discover there a Decomposition, and extract thence a Metallick Substance.

To these I might add other *Fossiles*, and some that were not, even by Men not unskilful, suspected to have any *Metalline* Ingredients. But I have not time to speak of Them;

Them, and therefore shall proceed in  
the lately begun Discourse.

### SECTION III.

**T**O illustrate then the general  
Observation, formerly laid  
down, and make it more distinct,  
I shall subjoyn the following Re-  
marks.

*First*, I do not pretend, by this  
Way, to make any more than pro-  
bable Conjectures and Estimates, a-  
bout the Contents of the Bodies, I  
examine by it: But tho' the Esti-  
mates, grounded on it, be not always  
True, yet they may be frequently  
Useful, as may be gathered from  
some of the subsequent Observati-  
ons.

*Secondly*, If the Fossile proposed  
be lighter, especially if it be much  
lighter, than so much Chrystal, it is  
an almost certain Token, that it is  
not

not a Metalline Ore. And this Negative use, if I may so call it, of our *Hydrostaticks*, may be more safely relied on, than the Affirmative Consequences usually can be. Thus, when I find that *Jet*, tho' a Fossile dug up in Veins, especially in the *Pyrenean Mountains*, (as a Learned Man, whose Brother has there a Mine of *Jet*, assured me) has far less of Specifick Gravity, than *Chrystal*; I conclude it to be no Metalline Body. The like Inference I make, on the same ground, as to Fossile Amber or *Succinum*, *Sulphur vive*, and the Observation holds in common *Sulphur*; (clear or *Semidiaphanous*) *English Talc*, *Venetian Talc*, and some other firm Concretions, whether Brittle or not, that are dug out of the Earth. Among these, I think fit to mention particularly *Black-Lead*, lest the Name it bears, should deceive Men into a Belief, that 'tis an Ore of that Metal. For having found its Weight, in reference to Water, to be but as  $1\frac{5}{16}$  to 1. And, gathering

ing from the Smalness of its Specifick Gravity, that it would prove to be very unlike our true common Lead Ores, I found, upon Tryal purposely made, that, 'twas a Mineral *sui generis*, and seemed, upon the score of more than one Quality, to be of kin to a sort of *Talc*, that I have met with.

*Thirdly*, We should distinguish between the several Uses, that Fossiles may be sought for, and examined, by Men of different Professions, or Designs. And therefore, if a Fossile be found to be somewhat, and yet but very little, heavier in *Specie*, than Chrystal or Marble; it may possibly have a Metalline or Mineral Portion, which, tho' very small in quantity, may consist of such Efficacious parts, as may make it deserve the Esteem of a Jeweller, a Physician, or a Chymist. But if the Surplus of Specifick Gravity be inconsiderable, the Fossile it self will be so too to a Mineralist, that seeks not to gratifie his Curiosity, or make a

good Medicine, but to fill his Purse. For the Charge and Trouble of working a Fossile, so poor in Metalline Substance, will probably either exceed the Profit, or keep it from being considerable ; whereas, if the Specifick Gravity do much exceed That of Marble or Chrystal, it may give good hopes of proving a Subject profitable to be wrought on.

*Fourthly*, But, here I must give notice, that, *tho'* for the most part, the great Ponderosity of a Fossile proceeds from a Portion of some Metalline Substance, more strictly so called, that is imbody'd with the other part of the Concrete ; yet this alone is indeed a certain Sign, that the Fossile is not a mere *Stone*, but is not alone a sure Sign, that the Mineral Portion is properly *Metalline* ; and therefore, where there is just Cause of doubt, 'tis best to endeavour by some Collateral Signs to resolve it. The Reason, why I thought fit to give you this Admonition, is, that, besides *Metalline Ores* more properly

perly so called, there are other Fossiles, which some call *Semi-Metals*, others *Media Mineralia*, and others again give other Appellations to; which Fossiles, tho' of Affinity to Metals, are wont to be distinguished from true Metalline Ores; such (Fossiles) as are (that I may here name the principal of them) *Antimony*, *Bismuth*, (usually in our Shops called *Tin-glass*) *Lapis Calaminaris*, and *Pyrites*, commonly called *Marcasites*, and vulgarly, in English, *Vitriol Stones*.) But there will not perhaps occur many Cases, wherein it will be necessary to have recourse to Collateral Signs, to discern, Whether the Mineral Portion of a Fossile, be, in a stricter Sense, of a Metalline Nature, or not: For these *Semi-Metals* that I speak of, are most commonly found either in Veins, or in Masses, or great Lumps of their respective Kinds; and easily discover, to one that considers them with so much as a moderate measure of Attention and Skill, what *Species* of Fossiles they belong to. I have in-

deed from *Devonshire* received a Lump of Matter, which the Owner of the Mine, not knowing what to make of, desired my Opinion of, wherein I found some *Antimony* mixt with Lead, which was the Predominant Body. But such Mixtures occur not often enough, at least here in *England*, to keep our Way of Estimating ponderous Fossiles from being, on most occasions, useful.

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#### S E C T. IV.

**F***ifthly*, It will be almost necessary to give you notice in this place, that there may be a two-fold Estimate made of the Specifick Gravity of Ores; *One*, when the Metal-line Body propos'd is weigh'd in its natural State, that is, as 'tis taken out of the Earth, accompanied with the Sparr, or other Heterogeneous matter, that firmly adheres to it, (only the loose Earth being first wash'd off :) and the *Other*, after it has  
been

been beaten small and separated from stony, and other Heterogeneous, Substances, by the help of Water; where being skilfully agitated, there is easily discovered a notable Disparity in Weight between these, and the Genuine, or Metalline, parts of the Ore, which being thus sever'd from the rest, are called, for instance, washed Tin, if afforded by a Vein of that Metal. And sometimes also 'tis very Useful, if not Necessary, to prepare the Ore by roasting it, (as they speak) once, or oftner, or by keeping it several hours in a competently strong Fire, as is usually enough done to prepare Copper Ore, especially if it be stubborn. I have distinctly mentioned these Two States, wherein the Weight of an Ore may be estimated; because, I have observed, that in several Cases 'twill much import the Experimenter to distinguish them carefully. For several Ores, which, in their natural State, have too little of Specifick Gravity, to make them judg'd worth the

Charge of being wrought, may yet, being prepared by Water and Fire, afford a Metalline Portion so heavy *in Specie*, that it may give fair hopes of containing in it some Portion of Silver, or of Gold ; and, in that case, a small Proportion of the Former, and a much smaller of the Later, would render the Ore considerable, and make it pretty Rich ; tho' not in reference to the quantity it yeilds of the predominant Metal, as Lead, Tin, or Copper ; yet in a more absolute Sense, as it may better recompense the Charges of him that shall work it. Which brings into my mind, that some time agoe a piece of Lead Ore, then brought out of *Ireland*, being offered me to judge of ; I found it so light in the Lump, that I thought it not at all worthy to be wrought for Lead ; but afterwards upon Tryal it appeared to be, tho' very poor in that Metal, yet so well stor'd with Corpuscles of Silver, that I scrupled not to incourage the Owner to bestow Pains and Cost upon it.

S E C T.

## S E C T. V.

**B**Ut there is one Kind of Minerals, that I have observed to impose on Men so often, that I think it necessary to take a particular notice of them in this place. For, not to mention Examples, that I might draw out of the Books of Travelers and Navigators, I have met with I know not how many, that have built great hopes, and some, (which is worse) that have been at Charges upon those illusory Expectations of great matters from *Marcasites*. And, I remember, I have had sent me, or brought me, not only from Places nearer home, but from hotter and colder Countries of the *Indies* themselves, Fossiles, whereof I was earnestly desired to give my Opinion, that I found to be but *Marcasites*: And many of these Fossiles having two Qualities, that make them very fit to

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delude the vulgar, and the unskilful, namely, first, a Multitude of shining streaks, or other glistering parts usually of a Colour near enough to That of Gold, and sometimes to That of Silver ; and then, a Ponderousness usually not inferior, at least, to that of true Metalline Ores ; *Marcasites*, I say, being thus fitted to delude the unskilful, I have had much ado to undeceive some, that brought or sent me them from *America*, of the pleasing Confidence they had entertained, that these promising Fossiles were Lumps of rich Ore of Gold, or Silver. Wherefore since their Ponderousness (which is the *Criterion* of Minerals, I am now treating of,) is One of the Two chief Things that delude so many, I think it expedient, to subjoyn some few, but various, Instances of the Specifick Gravity of *Marcasites*, whereby it may appear, that some of them are, Bulk for Bulk, far more ponderous than divers true Metalline Ores, that I have try'd, have been found to be. And indeed  
this

this great Ponderosity has several times invited me, before I made any Artificial Tryal of propounded Fossiles, and sometimes before I took them out of the Bags or Papers to look on them, to judge, tho' perhaps to the Surprize of those that brought them, that they were not true Ores, but *Marcasites*. And, because this Mistake is speciously grounded, and has deceived many, whereof some have undertaken Voyages betwixt *Europe* and the *Indies*, upon confidence of the value of these glistering Stones; I shall decline a little the Method of this Paper, which confines me to the Hydrostatical Way of exploring Minerals, to advertise those whom it may concern, that they may easily try almost any Stone, that, by its great Weight and Lustre, they suspect to be a *Marcasite*, if they put it, either within a Crucible, or, without One, into a well-kindled Fire, and blow now and then upon it with a pair of Bellows. For, by this means, the Sulphur, wherewith

*Marcasites*

*Marcasites* are wont to abound, (so that I remember, that even by Destillation in a close Vessel, I had ʒiv of good Brimstone, like the vulgar, out of ℥iij of the Stones) will take Fire, and burn with a Flame for the most part blew, like that of common Sulphur. And, if when it ceases to flame and smoak, you take it out of the Fire and let it cool, you will find it deprived of all the gaudy appearance of rich Metal it had before, and turned to a brittle blackish Substance, differing enough from That of a Metalline Ore, *more strictly so called*. These last words I add, because, in a lax Sense, 'tis easie to shew, that *Marcasites*, at least those that I have tryed, may be looked upon as a kind of Metalline Bodies. For, besides that I have found divers of them to contain Particles of Copper, I found all, that I purposely examined, to contain, and some of them plentifully enough, Corpuscles of Iron or Steel, as plainly appeared, when, after the newly mentioned Calcination,

Calcination, (for with crude *Marcasites* I found not the following Tryal to succeed) I applyed to the pulverized Remains a vigorous Load-stone; to which great multitudes of Martial Corpuscles quickly adher'd. And, I remember, I found in a Catalogue of the Fossiles of *Misnia*, published by the experienced *Kentmannus*, that, under the Head or Title of *Pyrites*, he brings in several *Marcasites*, whereof some contained Copper, others Silver, others Gold, and others both the last named Metals; which brings into my mind, that, having presented, among other English Minerals, a curiously shaped, and very fine *Marcasite*, to a *Virtuoso*, that is now Overseer of one of the Emperors best Mines; He quickly examined it by a peculiar Way, not known to me, hoping to find in it some Gold or Silver; but, instead of that, obtain'd a Portion of running Mercury, which he was pleased to present me, and which, I presume, I may have yet by me.

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Tho' I thought it needful to give the foregoing Caution about *Marcasites*, for the Reasons before express'd, yet my Design is, only to keep the less skilful from being deluded by their promising appearance. For otherwise I do not deny, but that 'tis possible for a skilful Artist, to make (at least of some sorts) of them a gainful use; *either* by fixing the *Volatile Gold or Silver*, that may be found in some of them; *or*, by graduating Silver, by their means; *or*, perhaps by some other Ways, that I can but guess at. But (to add That on this occasion,) that, for which I much more value *Marcasites*, is, That (NB) somewhat more than bare Conjectures make me think, that, being dexterously handled, and perhaps even without Additions, they may afford very noble, as well as uncommon, Medicines; and particularly in Continual Feavers, tho' their Operation be usually scarce sensible, but by their good Effects.

## S E C T. VI.

**O**N this occasion, I must not forbear to give an Advertisement, that may be of good Use to divers Examiners of Ores, especially such, as are Novices in the Art of reducing them. And it is This, that, as to many, who make Tryals of Ores, tho' they much value their own Flux-Powders, or Those that are cry'd up by others, yet they commonly act, as if they expected nothing from those that they prefer, but that they should more than Others facilitate the Fusion of the Ores; as that which being once done, the Metalline part will be separated by its own Weight, or, as it were, Spontaneously. But yet, having purposefully examined the Matter more nicely, and compared the Quantities of Metal, that we obtain'd from two Portions of equal Weight of the same Ore,

Ore, we found that those Proportions did very considerably differ, tho' that which yeilded least Metal was flux'd down with a *Fondant* (as the French compendiously call, what Our men, after the Germans, call a Flux-Powder,) that is dear enough, and not undeservedly esteemed, when such Ores are to be handled. And I little doubt, but that from other Metalline Ores, a greater Portion of pure Metal may be obtained by some, but little employed or known, *Fondants*, and perhaps cheap Ones too, than by Others that are much more in use and famous; Of which I may elsewhere give some Instances: Now, One that first occurs to my Memory, was afforded me, by two equally heavy Portions of the same Lead Ore devoid of Sparr; whereof One, being reduced with a due Weight of *Nitre* and *Tartar* fulminated together, afforded much less of Malleable Lead, than was obtained by means of half or a quarter of the Quantity of Filings of *Mars*, which, for Tryals sake,

I then imployed on the Other ; to shew, how much better a Reductive of that kind of Ore, that Metalline Flux was, than even a sharp and fiery fixt Salt.

And yet, (to give you an Instance in a much more precious Mineral than Lead Ore,) I shall add, that having, for Curiosities sake, try'd some Ounces of good native *Cinnabar* finely pulverized; one half with a fixt Alcaly of *Tartar*, and the other with a different Flux-powder, we obtained from the first Parcel twice as much Mercury, as we did from the other half, destilled with another fixt Alcaly ; even tho' it were of a Mineral Nature.

*Some Observations about Native Gold.*

S E C T. VII.

**G**old, being by far the most Noble, and Precious, of Metals, it may be ill taken, if I should here leave the Ore or Mineral, that affords About the Hydrostatical Examination of Gold and its Ore.

fords it altogether unmentioned; and therefore, tho' I have but Two, or Three, Observations pertinent to my present Subject, to offer about it, yet I think it may not be useless to say somewhat of that Ore in this place.

I know, there are many learned Men, and even Chymists, that think, there are no such things as *Gold Mines*, properly so called. And, I confess, that I my self was long kept from being confident of the Affirmative. And I was induced to this Diffidence by considering, that tho' having had the Honour for divers Years to be a Member of his Majesties Council for Foreign Plantations, I had the opportunity to converse with a considerable Number of Navigators, and other great Travellers, and with divers Persons, that had settled themselves in the *Indies*, I made it more than once my business to inquire, not, Whether they knew of any *Golden Mines* in the popular sense of the word, for, I knew, that there are in

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*Hungary, Macedonia*, and some other Countries, *Mines* that afford Gold enough to deserve to be wrought for it: but, Whether there are any real Mines, or Veins, whereof Gold is manifestly the predominant Metal. Having, I say, proposed to many this Question, I was answered, That some of them indeed had heard of such Mines, but none of them had ever seen any. But afterwards I saw some Ore that I judg'd true, that was presented to his Majesty (*Charles the Second*; and I also received from an unknown *Virtuoso*, residing in the *East Indies*, together, with a very civil Letter (which I wished had been more Historical and less Complementary,) among other less valuable pieces of Ore, One in whose Clefts, and a little beyond them, there appear some Lumps, wherein by their Colour, and other Signs, 'tis so apparent, that Gold is the predominant Metal, that I little doubt, but that, if I would spoil the Lump by breaking the Spar, I should find

these Metalline Protuberances Malleable, without the help of the Fire.

But being unwilling to destroy the Entireness of it, I shall make only a few, and short, Remarks about this Ore.

The biggest Piece, and that which was best furnished with Metalline parts, being about an Ounce and a quarter in Weight, contained so great a Proportion of *Spar*, in reference to the Metal, that its Weight to an equal Bulk of Water was but as  $2 \frac{9}{16}$  to 1.

But somewhat to compensate this Smalness of the Metalline Portion; That, that was of it, seemed to be all Gold, there being no Sign of any other Metal in that Lump of Ore, nor in some lesser Ones that I received with it.

The *Spar* (as our Mine-men use to call that stony Matter, in which the true Ore is immediately lodged,) did not look like the *Spar* of Lead Ore, or that of any other of our English Metals that I have seen, but seemed at first

first view to be a kind of white Marble with a dash of Yellow.

And upon Tryal, I found it to differ more from the *Spar* of Lead Ore, which, with us, is usually White, and almost *Semi-diaphanous* than in the Colour. For, whereas our *Spar* of Lead Ore is oftentimes so soft or tender, that it may easily enough be cut with a knife, we found the *Sparry* Portion of our Gold Ore to be a Solid stone, and that so hard, that, being struck with a piece of Steel, it would yield Sparks of Fire.

Whereas also I found, that the *Spar* of Lead Ore would be easily enough, and in a short time, (as about a quarter of an hour) calcin'd to a kind of Lime; our Golden *Spar*, tho' kept some hours red hot in a Crucible, did not appear to be at all calcined. And whereas I had formerly observ'd, that I could easily dissolve the *Spar* of Lead Ore in some *Acid Menstruums* and even in distilled Vinegar it self, I did not find, that our

Golden *Spar*, tho' kept divers hours in stronger *Menstruums*, as *Spirit of Salt*, *Aqua Fortis*, and *Aqua Regis*, was dissolved or manifestly wrought upon by any of them ; as if it were of a glassy Nature, as well as of a very hard One.

A piece of *Spar*, that had scarce any Gold at all that could be discerned, being Hydrostatically examined, was in Specifick Gravity to Water, as  $2\frac{65}{100}$  to 1, which Ponderosity does but very little exceed That of white Marble, or That of some good *Spar* of Lead Ore that was compared with it.

If I had received a greater Quantity of Gold Ore, I should have given a less imperfect Account of this Subject. But these Notes, such as they are, may, perchance, not be unwelcome to some of those many English and other Searchers for Mines, that have never seen true Gold Ore, or have not had Liberty to make any Tryals upon it, and yet are in Search of Gold Mines, especially in *Jamaica*,

*maica*, where, if I much mis-remember not, the \* inquisitive Gentleman, that conquer'd it for the English, told me, at his return thence, that the Spanish Governour of the Island, when his Prisoner, confessed to him, That there was Mineral Gold, tho' the *Spaniards* did not dig deep for it for want of Workmen.

\* General Venables.

## S E C T. VIII.

**B**UT by the mention I have made of the true Ore of Gold, I would not discourage any from seeking for that rich Metal in the Veins of some other Metals; because, in divers of these, I know it may sometimes be found blended with predominant Minerals. This may appear by those *Hungarian Copper Mines* of *Gremnitz*, whence a considerable Quantity of Gold is yearly obtained. I have elsewhere also taken

Memoirs for the Natural History of Ten.

notice, that I have seen an English Tin-Ore, Part of which I presented to the King, wherein there lay, in little Cells, a good number of small Leaves or Chips of Gold, which I saw there with pleasure. Andtho' the Tin-men, not being able to separate them with Profit, usually melted both the Metals together, and sold the Product for mere Tin; yet an experienced Gentleman, who was Owner of the Mine, assured me, that One of his Workmen, who had many little Children, imployed them with good Profit, to pick the Gold with their small Fingers out of the skilfully broken Ore. And *tho'* Lead-Mines be looked upon, as those, which the Matter, whereof Gold is made, is seldomest found to be near, and does as it were avoid; *yet*, there is a place in *Scotland*, (whose Name I remember not,) where, over a Lead Mine, upon or near the Surface of the Ground, they oftentimes find Grains or bigger pieces of Native Gold without *Spar*; some of which by the ingenious

genious Owners favour, I was Master of, and thought sometimes worthy of being presented to that curious Examiner of Ores, his Highness *Prince Rupert*. And still I have one bit of Native Metal by me, which, if I much mistake not, I had from the same place: which Fossile, tho' I found it Hydrostatically (because being Native I would not melt it) not to be, as the Owner suppos'd, pure Gold; yet Gold is the predominant Metal in it, and the piece weighs forty odd Grains.

Since I wrote the last foregoing Lines, I have, in an old Collection of my Notes, found Three; whereof the *First* is thus set down, *A Grain of Scotch Gold, such as Nature had made it, without any adhering Stone or Spar, weighed 3iij + 21 Grains*: The *Second* thus, *Another Grain of the same Gold, that had here and there some little Stone or Spar sticking to it, and partly inclosed in it, weighed 3iij + 3 Grains*; So that the Heterogeneous Substance being, according to

my Estimate, abated, it weighed about 3iii: And the Third is subjoyned in these Terms, *A Grain of Beach Gold weighed in Air, 43 Grains; in Water, 39  $\frac{1}{2}$  Grains: Differ<sup>3</sup> in Proportion to 1.* Now, you yd lase M. evitah to  
 This Lightness of a Yellow Metal (heavier than Brasse or Silver) deserves a Reflection; but I cannot stay to make it. Now I evitah M. gaid  
 It several times happens, that, among the lesser Grains of Gold, that are more properly called *Sand-Gold*, there are found pieces, some of which I have seen, that are singly big enough to be tyed about with an Horse-hair, and so weighed in Water, as Lumps of Ore of other Metals are wont to be. And to such bigger Fragments of Gold, 'tis manifest, by what has been already delivered, that our Hydrostatical Way of exploring may be usefully applyed. For since, according to the famous and diligent *Mersennus*, and some esteemed Writers, pure Gold is to Water of the same Bulk, as (about) 18 to 1; and by

by my *Examen* of very fine Gold, I found, that it equals *about* Nineteen times the Weight of as much Water, (I say, *about*, because I unhappily lost the exactest of my Tryals upon Gold, among those made upon the other Metals in a most exquisite Ballance) as is equal to it in Bulk; it will readily appear, Whether the Fragment propos'd be perfectly pure or not. For, if its Weight amount to near Nineteen times as much Water in Quantity, we may conclude it to be unallayed; and, as it wants less or more of this Ponderosity, we may conclude it to be more or less pure.

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## SECTION IX.

**I**S known, that, since we began effectually to cultivate the *African* Trade, it frequently brings into these Parts, besides things of less value, considerable Quantities of what, from the most usual Size of it, is

is by many called *Sand-Gold*; but which, by reason of the very unequal Bulks of the Grains, may perhaps justly be called *Fragments of Gold*; since being brought from the Maritime parts, where no Mines of Gold are yet found, they seem to have been broken off and washed away from hidden Veins by the violence of Waters, that, having carried them as far as they were able, left them a Prey to Men. Now, (because that unless it be perhaps brought by, or for, some *Virtuoso*) there is scarce any Gold that comes into *Europe* in Lumps, under the form of *Ore*; but a great deal that is brought from *Guinea*, (and those other parts of *Africk*, which, for that reason, are comprized under the Name of the *Golden Coast*) in the Form chiefly of *Sand* or *Gravel*, grosser or smaller, and partly also of less minute Pieces; it may conduce to the scope of these Papers to take notice, that, in making Estimates of the Genuineness, and the degrees of Purity of these native  
Fragments

Fragments of Gold, our Hydrostatical Way of exploring may be of no small use.

For *first*, when we have once discovered the Proportion between pure or exquisitely refined Gold, and Water equal to it in Bulk; (which Proportion I have lately given exactly enough, for our present purpose,) tis easie, by our Hydrostatical Method, to examine the Fineness of any other Gold proposed; so, at least, as to know, whether it be perfectly Fine; and if it be not, whether it do considerably fall short of perfect Fineness. But since of this I elsewhere treat, I think it more proper to observe in this place, that when once a Man has found the true Specifick Gravity of a parcel of Sand-Gold, (smaller or courser,) whose Degree of Fineness he knows by Collateral Tryals, or some other Means, (whatever they be) He may (as was formerly noted when I spoke of Metalline Ores,) take this Specifick Gravity for a Standard, with relation  
to

to which, he may make his Estimates of the Fineness of other parcels of the like native Gold, that he is concerned to buy, or to examine. And, by this means, he may oftentimes prevent that chief Fraud of the *Negroes*, whereof several Traders to the Golden Coast are not a little apprehensive; as being in danger to be much damnified by it. For they complain, that, tho' the *Blacks* be otherwise, for the most part, but a dull sort of People; yet they have often made a shift to cheat the Traders, by clandestinely mixing, with the right Sand-Gold, Filings of Copper, or rather of Brass, whose Colour does so resemble that of Gold, that the Fraud is not easily discerned. And in the Account of a late Voyage, made by the French, to the Coast of *Africk*, to Trade especially for Gold, 'tis acknowledged, that the Officers were egregiously cheated by the *Blacks*, who, instead of paying them for the Wares they brought, with Powder of true Gold, gave them Powder of Brass,

Brass, or gilt Copper, which those that were not accustomed to make Tryal of, are, as the Relater complains, ~~such Wares~~, in a scarce evitable danger to be cheated: as these French men confess they were in one day to the worth of a thousand Crowns. But, in regard, that, as Tryal has informed me, Brass is not quite half so heavy as fine Gold of the same Bulk; if there be any considerable Quantity of Filings of Brass with the Gold; This Mixture being put into such an Hydrostatical Bucket, or wide-mouth'd Glass, as is mentioned in the Essay, will manifestly weigh less in Water, than if it were all Gold. And by comparing its Specifick Gravity, with that formerly found, to the Grain-Gold pitched upon for a Standard; the greater or lesser Decrement of the suspected Gold, will help to make an Estimate of the Quantity of Brass, mingled with the natural Gold.

## S E C T. X.

**B**Ut, *tho'* my present Undertaking do not oblige me to consider Sand-Gold, otherwise than Hydrostatically ; and, *tho'* it highly concerns Merchants and Others, that deal in so rich a Commodity as Gold, and that is by so many studiously adulterated, to be furnisht with nice and trusty Ballances ; yet, because divers Persons, especially Sea-men, that trade to the Gold Coast and other parts, where Sand-Gold is to be met with, do, (perhaps too often) without being furnisht with good Scales and sufficient skill to use them, venture upon buying such precious Wares ; it will not be to depart from my general and main Design, which is to serve the Publick ; if I deviate a little from my Subject, and add to the Hydrostatical Way, lately proposed, of examining Sand-Gold,

Two or Three Chymical ways to the same purpose. First, then, if he, that would purchase Sand-Gold, doubts, that there are Filings of Brass (or of Copper) mixt with it; in case he have *Aqua Fortis* at hand, he may quickly discover the Cheat, if there be any. For, 'tis known to Chymists, that *Aqua Fortis* will not work upon Gold, and therefore, if there be Filings of Brass mixt with it, the Operation of the *Menstruum* upon those, together with the Colour betwixt blew and green, it will thereby acquire, will discover the Deceit. But, because if Nature hath mingled much Silver with the Gold, the Proof by *Aqua Fortis* will require Skill, and may puzzle those that want it; I shall add, that good Spirit of Urine may be substituted in its stead. For, I elsewhere shew, that 'twill readily work upon Filings of Copper or Brass in the Gold, and gain from them a fine blew Colour; and this being a *Menstruum* not corrosive, like the other, but harmless to most Bodies, and a good Medicine  
for

for *human* Bodies in several Diseases, (as the *Jaundice*, *Pleurisies*, some kind of *Feavers*, *Coughs* and *Asthma's*) may be fit to be carried about in Voyages, and to be preferr'd to *Aqua Fortis*. And, to make the Operation of this Liquor on Filings of Brass far more quick, than if the Solution be attempted an ordinary Way; I thought upon the following Expedient. I took Filings of Brass, (and the like may be done with those of Copper,) amounting to the Weight but of Eight or Ten Grains, or perhaps less; and having with my Finger spread them somewhat thin upon a small piece of white Paper, I moistned them thoroughly with good Spirit of fermented (or putrified) Urine, (which will not dissolve Gold) that, by this means, the Air might promote the dissolutive Action of the *Menstruum*; which, accordingly, it did so well, that, to the surprize of the Beholders, there appeared, in less than a quarter of an hour, and sometimes in a few minutes, a manifest, if

not

not also a deep and pleasant, blew Colour upon the Paper, or on some of the Filings, (~~or~~ both.) Those that carry with them Spirit of *Hartshorn*, or such other Volatile Alcalys for Medicinal Uses, (as some modern Ship-Chirurgeons do;) may, for a need, imploy That instead of Spirit of Urine. Nay, one may for the same purpose make use of Urine it self never destill'd, if it be Stale and Rank enough, (as it grows to be, sooner in hot Airs than in others!) Since having for Tryals sake moistn'd with such Urine some Filings of Brass, thinly spread on a piece of Paper, there was a manifest Blewness produced in about a quarter of an hour. But I thought also of another Way, which I presumed would be better lik'd by most Traders, as more Commodious; because the Agent, being in a dry Form, cannot, like Spirituous Liquors, be spilt; and tho' it be more easily procur'd, may serve the turn almost as well. This Agent is common *Sal Armoniack*, of which,

○

when

when I have occasion to use it, I reduce a greater quantity to Powder, than I guess the quantity of Water, I shall need, will dissolve; that the Liquor may be satiated with the Salt. With this Brine I thoroughly wet Filings of Brass, (or Copper) after the forementioned manner, thinly spreading them with my Finger on a piece of Paper, or some other fit and flat Body; and in a short time (as about a quarter of an hour or less,) there will appear a Greenish blew Colour, drawn from the Brass by the Liquor: Which (Liquor,) I suppose, I need not tell you, will not work on the Gold, wherewith the Brass is mingled.

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## S E C T. XI.

**I** Have observed such a Variety of appearances, and disguises, of Metalline Bodies, and some other Minerals, that I would advise those that  
are

are given to the Search of Mines, and other Fossiles, to have their Eyes always open, when they pass (especially by Land) from one place to another; that they may be ready to take notice of any unknown, or uncommon, Fossile, that they chance to see in their Way; and that having taken it up, they do not neglect to p<sup>o</sup>ss<sup>ess</sup> it in their hands (which after a little Practice 'twill not be difficult to do, tho' not exactly, yet not unusefully) and, if they judge it to exceed the Weight of Chrystal, or Marble, to examine it Hydrostatically at their first Conveniency. For there are in *England*, as well as in divers other Countries, useful Fossiles, that are wont to be overlooked by the unskilful; and I have found in this Kingdom, even upon, or very near, the Highways, Eagle-stones; and some other Minerals, that were not suspected to be of English growth. And, I remember, that having occasion, in the Country, to pass by the Work-house of an ingenious Potter;

*x poyse*

that I sometimes imploy'd in his Profession; and having view'd the ground somewhat attentively, among some other uncommon Fossiles that I took notice of, I made a discovery of *Manganese*, or *Magnesia*, whereof I gave the Potter an Advertisment, which he afterwards thankfully made use of, having found the Mineral very proper for the glazing and and colouring of his Vessels.

Nor was this the only kindness, that skill in Mineralogy, as little as mine was, enabled me then to do him. For he having invited me to view, very privately, a place wherein there was great store of a Fossile Substance, that Men knew not what to make of, because they had not seen, nor heard of, the like in *England*: The knowledge I had of some *Italian* Mines, made me quickly guess, What it was that was taken for an unknown Metal. For 'tis true, that this Mineral was not divided into Lumps of such Shapes and Bignesses, as make glittering Fossiles pass for  
Stones

Stones among the unskilful, such as are the *Marchasites* whereof they make *Vitriol*, and are found by the Sea-shore, in or near the *Isle of Wight*, and, (tho' not so plentifully) in other parts of *England* (where I have found them;) but ran a great way (and I had not Time or Liberty to try How far) under ground, like a Veine of Metalline Ore. But this notwithstanding, I judg'd the Mineral to be but a *Marchasite*, in a Form, unusual indeed in *England*, but which is not without resemblers in some parts of *Italy*; which Conjecture I found true the same day, by some easie Tryals, that manifested it to abound much more in *Vitriolate* Salt, than any *Marchasite* that I had examined in the form of Stones. So that, tho' I had no opportunity to try, whether or no it contained any better Metal than Iron; yet I concluded, that, *Ceteris paribus*, it might be employed to to make store of *Vitriol*, in far less time, and with far less cost, than the

*Marchasites* made use of, in the *Vitriol Works* at *Deptford*, or elsewhere in *England*.

I remember also, that a Mineral of an odd, tho' pretty, appearance, being sent me, whose Species was unknown to the Mine-men that dug it up, I guess'd that it was a Fossile, that I had not found in a good Printed Catalogue of our *English* Minerals, (namely) the Ore of *Bismuth*. And in this Conjecture some Tryals, purposely made of that Mineral, sufficiently confirmed me; and gave me cause to be sorry, that the Vein, that afforded it, was so very small, as the Diggers found it, of an Ore, that has Properties Curious enough; and is by some famous Chymists affirmed to have some that are, not only Rare, but Wonderful.

But the chief thing that invites me to recommend, in this place, to those that Travel, an heedful eye on the Ore-like, or ponderous Substances, that may occur to them, is, That One of the Applications of our general

neral Remark, about the Specifick Gravity of Fossiles, may be extended to an Use, that has not, that I know of, been made by Mineralists, ~~and~~ and which yet I thought fit not to overlook: because I see no need, we should be confin'd to examine only those Fossiles, whereof we can obtain Parcels, big enough to be weigh'd in Water in the entire Body. For besides other Minerals, that may be found profitable to the Physician, the Drugster, or the Mineralist; the Ores, or Wombs, of Metals themselves, may be divers times found disguis'd in the Form of Earth, or of Mud, easie to be dry'd: Which Fossiles, tho' (because they chance not be found in Lumps) unfit to be kept immediately suspended by an Horse-hair; may be conveniently enough examined by the help of a Glass-Jar, whose Weights in Air, and Water, and their Difference, (which gives the Specifick Weight of the Vessel) have been taken once for all, which I usually call an Hydrostatic

cal Bucket. For this Vessel, being almost filled with the propounded Fossile, and carefully counterpoized in the Air, and then thorowly wetted with Water; and when 'tis so, warily let down into the Water, and kept suspended by an Horse-hair to a tender Ballance; when, these things, I say, are done, the Difference between the Weight of the Mineral and Vessel, when they are under Water, and their former Weight, being observed; and the Specifick Weight already found of the Vessel it self in Water, being subtracted from that Difference; there will remain the Weight of the Fossile only, (which we here suppose, to be heavier *in Specie* than Water, and not to be dissoluble in it) or the Mineral it self, in that Liquor; and consequently, the Proportion between that Body, and Water of the same Bulk, as is elsewhere sufficiently declared.

## S E C T.

## S E C T. XII.

**T**O manifest, that This Expedient may be of use in divers Cases, I shall only here observe, that a late Author, who hath published an Account of *Swedland*, declares, that one of the best sorts of *Swedish* Iron (which, you know, is much esteemed in its kind) is divers times found, in the Form of a red Mud, at the bottom of Lakes, or far lesser Stagnant Waters : which I the more readily believe, because I have found some English *Okers* (that pass but for red Earth, or Stone of that Colour ;) to be richer in Iron, than I found some famous Ores of that Metal to be. And another experienced Writer, who gives us an Account of the Gold and Silver Mines of *America*, among which he spent several Years, takes notice, that Gold it self is found, from time to time, disguised into a reddish

*Vanne-  
chio.*

reddish Earth, or is (tho' unsuspect-  
edly) harbored in it. An *Italian*  
Mineralist, of repute in the last Age,  
doth also take notice, that a reddish  
sort of Earth doth sometimes con-  
tain a Portion of the richest Metals.  
I have observed some *European*  
Diamonds, as many call a sort of  
clear and finely-Figured Chrystals, to  
grow in a red Earth; whence I have  
taken up pretty store of them. And  
an inquisitive Traveller, who has  
been in the *Indies*, presented me with  
a certain Earth, which he affirmed  
to be from the Diamond Mines, (I  
presume, in the Kingdom of *Colchonda*)  
which I found to be also red, and  
which I made some Tryals of, that  
belong not to this place.

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### S E C T. XIII.

**B**Ut the profitablest Use, that a  
Mineralists may make of our  
Hydrostatical Bucket, is, to imploy  
it

it much in weighing Variety of coloured Sands, and Gravels; particularly, some hereafter to be mentioned.

And to let you see, by an easie Instance, how apt we are to overlook Sands for want of trying them by Weight, I shall not tell you, that I have sometimes seen a sort of Sand that was slighted as common or worthless, which, being washed and viewed in a *Microscope*, tho' none of the best, looked like an Aggregate of small Granats, and perhaps was so; but shall here content myself to instance in that black Sand, that is commonly used in *London* and elsewhere, only to dry up the Ink of Words that have been newly written. For having observed when I had some quantity of this in my hand, that it was manifestly heavier than common Sand; I thought it worth the being examined by the Hydrostatical Bucket; by which Tryal, that which we imployed, appeared to be to Water of the same Bulk, near about as  $4\frac{6}{10}$  to 1. And having

having, for Reasons that I cannot stay to mention, judg'd this Sand to be a Mineral of a Martial Nature, I was confirmed in my Conjecture, by melting it down with two or three parts of Antimony, and casting it into an Iron Cone. But I was more than confirmed in the same Conjecture, when, having try'd it with a vigorous Loadstone, I found it to be far richer in Metal, than any of the *English* Iron Ores I had made Tryal of, and (except perhaps One) than any of the Outlandish: For, having taken, at adventures, some Drams out of a much larger Quantity, and weigh'd it; I found, that at least Seven parts of Eight would easily be taken up by the Magnet. But such Observations as these, are not the things that chiefly move me to recommend the *Examen* of Sands and Gravels to the Mineralist; particularly, those sorts of them, that, being somewhat ponderous, are Reddish or Yellow, especially if they retain those Colours, after they have been made red hot, and quenched in cold Water. But

*But* Therefore to proceed to the mention of richer Sands, 'tis known, That, from the Coast of *Guyny*, *European* Traders, of several Nations, do yearly bring Gold, to a great value, which is washt or pickt out of the Sand. And even in *Europe* there are Rivers, whose Sand is inricht by Grains of Gold, for which the *Tagus* that runs by *Lisbon*, and *Paetolus*, were famous among the Ancients. I knew an industrious Chymist, who owned to me, that he got Gold with Profit, from the Sand, which he found in some places of the Banks of the *Rhine*: and there is a litle River in *Savoy* proceeding from the Mountains there, on whose Banks, after a Land Flood, I saw poor People busie themselves in seeking for Grains of Gold. Some Tryal, (also) that I caused purposely to be made, confirmed me in a Conjecture, which possibly may hereafter prove Beneficial to many; namely, that the Sands of divers places, if they be Skilfully treated by a dextrous Chymist, may afford

afford much more Gold, than is pickt or washt, out of them in Form of Grains. For besides, that there may be many Atoms, or Corpuscles, of Gold that are so very minute, and stick so close to Grains of Sand, that they are neither taken notice of by the Eye, nor separable by washing, and picking; besides this, I say, there may, as I conceive, be many Particles of Gold incorporated with the Body of the Sand, which may be a Kind of Womb for matter of a Golden Nature, that a skilful Artist, by the help of proper Additaments, may separate with Profit; especially, if, with *Litarge* or *Minium*, he first reduce the Sand to a Glass, and then take care to get the *Volatile Gold*, by giving it a pure Body fit to retain and fix it, such as is fine Silver: Out of which, I remember, we separated by *Quartation*, (tho' without Profit, because of the Charges, and of the small Quantity we could work with at once,) from as much vitrified Sand, and two or three fluxing Additaments

ditaments of small price, as were contained in one Crucible, (that broke too, before Operation was near done,) sixteen Grains of pure Gold; that you may yet see, if you desire it.

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### S E C T. XIV.

**I**T need not startle you, that, in reciting this Experiment, I made mention of *Volatile Gold*. For, tho', I know, that divers learned Men, and some able Chymists themselves, look upon it as a Fictitious thing; and that seems to bear a kind of Contradiction in its very Name; in regard of the perfect Fixity they presume to be an Essential property of Gold: yet I do not scruple to dissent from them, being warranted so to do by my own Experience. For, I have, more than once, made use of a Way, wherein, by the help of an Additament, inconsiderable as to Bulk, and less as to Weight; one may, with-

our

out a naked Fire, and in a Glass retort, sublime Gold, (not prepared by previous Calcination) sometimes in the Form of a yellow, or golden coloured, Salt; and sometimes, when the Operation succeeded better, in the Form of thin Chrystals prettily shapt, Glossy, and as red as Rubies. But this upon the by; it may perhaps be more useful to Searchers of rich Fossiles not found in Lumps, if I take this occasion to observe, that when they meet with Sands, Earths, Mineral Fragments, &c. that considerably exceed Chrystal in Specifick Gravity; and by the Place wherein they are found, or by other Tokens, give hopes of their containing Corpuscles of a golden Nature: When this, I say, happens, it will not be adviseable, hastily to reject such Bodies; but rather carefully to try, Whether they do not deserve a better Usage. For, having sometimes had the opportunity to discover Corpuscles of *Mars*, as Chymists call Iron and Steel, in a far greater Variety of Fossiles,

Fossiles, and of Disguises, than even many noted Chymists would have imagined, or some of them could, upon heedful Tryal, discover; I was much confirmed in my Suspicion, That Corpuscles of a Golden Nature may be concealed in divers Bodies, which are thought not to contain ~~any~~ Metal; and that in more of those Minerals, that are lookt upon as Ores of some other Metal, because of its being manifestly Predominant; there may be mingled pretty store of Particles of Gold or Silver; which, (because of the greater Quantity of that other Metal, or Mineral, that doth, as it were, cover, or disguise them;) lye unperceived, & usually unsuspected, by Persons not very well acquainted with such Matters; and yet may, by One that is very skilful, be separated even with Profit.

SECT.

## S E C T. XIII.

**B**UT the Grounds of the forementioned Suspicion being as yet but Conjectural, I shall decline the particular mention of them in this place; and shall rather *Advise*, with reference to Ores in General, that those that would apply the Hydrostaticks to Them, do labour to procure Samples of the Ores of differing Mines, especially if they be found in the same Country; and do either by Tryal or strict Enquiry inform themselves, what Proportion of the Metal, that denominates them, they contain. For these Portions of Ores and Minerals, being carefully weighed in Air and Water, and their Specifick Gravities, being thereby made known, they may serve for a kind of Standard, by Comparison whereto we may oftentimes

tentimes make not altogether un-  
 useful Estimates of the Metalline  
 Portions contained in other Parcels  
 of Ore, of that *Species*, whether  
 afforded by the same Mine, or Vein  
 of it, or by any other of the same  
 Metal) Hydrostatically examined.

For Instance, our English Lead-  
 Ores, that are worth taking no-  
 tice of, may be, for distinction sake,  
 divided into Three Kinds or Orders,  
 and in each of these, there may be  
 allowed a Latitude for greater, or  
 lesser, Degrees of Goodness. The  
*First* sort is of those Ores, that, in the  
 ordinary Way of melting, hold some  
 of them from 30 lb of Lead, in an hun-  
 dred Weight of Ore, to 40; and others  
 to 45 lb of the same Metal, and these  
 by several are slighted, as mean;  
 and scarce, if at all, worth work-  
 ing; especially, those that hold un-  
 der 35 or 40. As for the *Second*  
 sort, that reaches from 45. to 60 lb,  
 in the hundred; the most usual Pro-  
 portion, I have found in many Try-

als hath been about half the Weight of the Ore in clean and Malleable Lead. These Ores are thought in, differently good and worth working: But other Ores comprised in this Second sort, held about 55, and some near 60, and these were lookt upon, not only as Good, but pretty Rich. And for the *Third Sort*, it consists of those that yield from 60 to 80. in the hundred, and these Ores are justly reputed very Rich, (in lead) especially these that come any thing near 80; for, I confess, I never met with any that reacht so far, but was assured by an ingenious & skilful Gentleman, Master of his Majesties Royal Mint, that he had found some such upon Tryal. But for me, I think that I have not above twice or thrice met with any that yielded me above 75. These lookt exceedingly Promising, as if they were all Metal, and I observed, whether the thing were casual or not, some Lumps to be composed of

of divers great Cubes like Dice, sticking very hard to one another.

The Considerations, that moved me to offer the Advice given at the beginning of this Section, invited me to make Researches of the Specifick Gravity, *not only* of divers English Ores, as of Lead, Tin, &c. Of which I had carefully made a Collection, (that was lost by a sudden Fire, broke out in the place where I kept them,) but of the Ores that were presented me from several Countries, both in *Europe* and *America*; as *Swedish* Copper and Iron Ores, *German* Silver and Tin-Glass Ores; *Hungarian* Antimonial Ores; *New English* Lead, Iron, and Copper Ores, &c. The Effects of some few of which Researches, that chanced to come to hand, whilst I was seeking for some Hydrostatical Tryals of Drugs, I thought it not amiss to insert in a Table annext to the *Medicina Hydrostatica*; because perhaps they may be of some

use, in making a previous Conjecture, about a Mines being, or not being, likely to be wrought with Profit, *all other things concurring, that should do so.* Which last Clause I desire should be taken notice of; because there are divers other Circumstances, besides the Proportion of the Metalline part in the Fossile, that are fit to be considered, [as, *the* Plenty, or Scarcity, of the Mineral; *the* Easiness or Difficulty of coming at it, because of *its* depth, or *its* being, or not being troubled with Waters, &c; *its* Nearness to Plenty of Fuel; and the Conveniency of Water to drive Mills; *its* Nearness to, or Remoteness from, the Sea, or some Navigable River, convenient for *its* Transportation, to omit other important Circumstances] before One begins to work a Mine; which as they happen to be Commodious, or Inconvenient, may render the Attempt Adviseable, or Imprudent.

But

But Sir, I perceive, (tho' late) that I have forgot, I was to write, not a Book of the Tryal of Ores, and other Minerals, but a moderately, sized Letter, about an Hydrostatical Way of Exploring their Specifick Gravity. And therefore, to avoid increasing the already too great Prolixity of this Paper, by making an Apology for it, I shall lengthen it, only to beg you to Pardon it, and to look upon the Writer, as

S I R,

*Your most humble and*

*Obedient Servant*

R. B.

P 4

Adver.

*Advertisement.*

**T**O give the Curious the Satisfaction of seeing at one view, and so of easily comparing together, the Specifick Gravities of all good Number and Variety of Bodies; and to save them the labour of turning over many Leaves of the foregoing Tract, to find the particular Body, whose Ponderosity they desire to know; I have caused to be annexed a Table, containing in an Alphabetical Order (tho' not a scrupulously exact One,) the Names of the Drugs, and other Bodies, whose Gravities are delivered in the foregoing Papers; without scrupling to add some others, that I chanced to light on, in turning over some of my old and forgotten Notes.

But

But I must to the following Table premise this Advertisement, (warranted by several passages of the foregoing Papers here laid together) That 'tis not to be expected, Every one that shall try the Specifick Gravities of the Bodies here mentioned, shall find all of them to be precisely the same, that the Table exhibits: Since, (not to mention, that perhaps every Experimenter will not imploy so much Care, and be assisted with so much Use, in making Hydrostatical Tryals, as Those this Table consists of were made with) the Difference, that may sometimes be found between his Tryals and mine, may very probably be imputed to that Variety of Texture and Compactness, that may be found in several Bodies of the same kind, or Denomination; neither Nature, nor Art, being wont to give all the Productions that bear the same Name, a Mathematical preciseness, either in Gravity or in other Qualities.

# The TABLE.

A	Weight In Air in Gr.	In Wa- ter in Grams.	Proportion.
<b>A</b> Mber . . . .	306	12	$1 \frac{4}{105}$ to 1.
Agat . . . .	251	156	$2 \frac{64}{105}$ to 1.
A piece of Allom- stone . . . .	280 $\frac{1}{2}$	152 $\frac{1}{2}$	$2 \frac{18}{105}$ to 1.
Antimony good and supposed to be Hungarian One-	391	295	$4 \frac{7}{105}$ to 1.

## B

Bezoar stone . . . .	187	61	$1 \frac{48}{105}$ to 1.
A piece of the same--	56 $\frac{1}{2}$	22	$1 \frac{64}{105}$ to 1.
A fine Oriental one --	172	60	$1 \frac{53}{105}$ to 1.
Another . . . .	237	61	$1 \frac{34}{105}$ to 1.

## C

Coral red . . . .	129 $\frac{1}{4}$	80 $\frac{1}{4}$	$2 \frac{63}{100}$ to 1.
Chrystal . . . .	256	140	$2 \frac{21}{105}$ to 1.
Cornelian			

# The Table.

	Weight In Air in Gr.	In Wa- ter in Grains.	Proportion.
Cornelian . . . .	148	103	$3 \frac{29}{100}$ to 1.
Calculus humanus---	2570	1080	$1 \frac{72}{100}$ to 1.
Coco-shell . . . .	331	85	$1 \frac{34}{100}$ to 1.
Native Crabs Eyes .	$77 \frac{1}{2}$	$36 \frac{1}{2}$	$1 \frac{89}{100}$ to 1.
Crabs Eyes Artificial.	$90 \frac{1}{2}$	54	$2 \frac{48}{100}$ to 1.
Calx of Lead . . .	$138 \frac{1}{2}$	123	$8 \frac{94}{100}$ to 1.
Copper Stone . . .	$65 \frac{1}{2}$	$49 \frac{1}{2}$	$4 \frac{09}{100}$ to 1.
Common Cinnabar--	802	702	$8 \frac{1}{100}$ to 1.
Cinnabar of Anti- mony . . . .	197	169	$7 \frac{3}{100}$ to 1.
Cinnabar Native--	197	171	$7 \frac{57}{100}$ to 1.
Coral White . . .	336	204	$2 \frac{54}{100}$ to 1.
Another piece fine --	139	85	$2 \frac{57}{100}$ to 1.
Calculus humanus --	302	97	$1 \frac{47}{100}$ to 1.
Copper Ore . . . .	1436	1090	$4 \frac{15}{100}$ to 1.
Copper Ore Rich . .	413	314	$4 \frac{17}{100}$ to 1.
Cinnabar Native , very sparkling . .	226	194	$7 \frac{6}{100}$ to 1.

G.

Gold Ore not Rich,  
brought from the  
East Indies . . . 1100 682  $2 \frac{63}{100}$  to 1.

Ans.

# The Table.

	Weight In Air in Gr.	In Wa- ter in Grains.	Proportion.
Another Lump of	841		
the same	1151	717	$2\frac{62}{100}$ to 1.
Granati Minera . . .	217	147	$3\frac{10}{100}$ to 1.
Granate Bohemian . . .			$4\frac{36}{100}$ to 1.
OH			
Hematites English	1574	1156	$3\frac{76}{100}$ to 1.

## I

Ivory . . . . .	173 $\frac{1}{2}$	83	$1\frac{101}{100}$ to 1.
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## L

Lapis Manati . . . . .	450	293	$2\frac{86}{100}$ to 1.
A Fragment of the			
same . . . . .	218 $\frac{1}{2}$	123	$2\frac{29}{100}$ to 1.
Another . . . . .	345	197	$2\frac{11}{100}$ to 1.
Another from Ja-			
maica . . . . .	2011	1127	$2\frac{27}{100}$ to 1.
Lapis Lazuli one			
piece . . . . .	385	256	$2\frac{28}{100}$ to 1.
Lead Ore . . . . .	686	590	$7\frac{14}{100}$ to 1.
Another . . . . .			

Lapis

# The Table.

	Weight In Air in Grs.	In Wa- ter in Grains.	Proportion.
Lapis Calaminaris--	477	380	$4\frac{22}{100}$ to 1.
Lapis Judaicus	261	164	$2\frac{69}{100}$ to 1.

## M

Marcasites	814	631	$4\frac{61}{100}$ to 1.
Another from Stal- bridges.	243	189	$4\frac{1}{100}$ to 1.
Another more shi- ning than ordi- nary.	287	227	$4\frac{78}{100}$ to 1.
Mercury reviv'd from Ore			
Manganese a piece--	321	230	$3\frac{51}{100}$ to 1.
Mineral Cornish like a shining Marca- site	145	129	$9\frac{6}{100}$ to 1.

## O

Osteocolla	195	108	$2\frac{24}{100}$ to 1.
Ore Silver choice from Saxony	458	366	$4\frac{22}{100}$ to 1.
Another Piece	1120	960	7 to 1.

Ore

# The Table.

	Weight In Air in Gr.	In Wa- ter in Grains.	Proportion.
Ore Lead from Cum- berland Rich . .	1872	1586 $\frac{1}{2}$	$1\frac{12}{100}$ to 1.

## R

Rhinoceros horn . .	8563	4260	$1\frac{22}{100}$ to 1.
Rock-Chrysal, ano- ther Piece . .	256	140	$2\frac{12}{100}$ to 1.

## S

Saphir . . . .			
Seed-Pearl . . . .			
Sulphur vive . . .	371	185	2 to 1.
Germane very fine .	306	152	$1\frac{24}{100}$ to 1.
Slate Irish . . . .	779	467	$2\frac{22}{100}$ to 1.

## T

A Piece of Talc like

Lapis Amian- thus . . . .	596	334	$2\frac{24}{100}$ to 1.
Venetian . .	802	508	$2\frac{12}{100}$ to 1.
Talc { Jamaican . .	1857	1238	3 to 1.
			New

# The Table.

Weight In Air In Water in Grains. Proportion.

## New English Tin

Ore, Mr. Huberts.	812	613	$4\frac{1}{100}$ to 1.
Tin Ore black Rich.	1293	984	$4\frac{1}{100}$ to 1.
Another piece Choice.	2893	2314	5 to 1.
Tutty a piece . . . .	104	83	5 to 1.
Tin-glass . . . . .	468	419	$9\frac{1}{100}$ to 1.

## V

## Vitrum Antimonii

per se . . . . .	357 $\frac{1}{2}$	282 $\frac{1}{2}$	$4\frac{1}{100}$ to 1.
Vitriol Engl. a very fine piece . . .	1093	512	$1\frac{1}{100}$ to 1.
Unicorns horn a piece . . . . .	407	195	$1\frac{1}{100}$ to 1.

Post-

## POSTSCRIPT.

**W**Hen I began to send the Essay, called, *Medicina Hydrostatica*, to the Press, and drew up the foregoing Preface to it, I intended it should in the same Book or Volume, be accompany'd by another Help or two, to explore, and Improve the *Materia Medica*. But when the Essay it self, and the annex'd Epistle about a previous Exploration of Ores had been Printed off; I could not but perceive, that the Bulk of those two Tracts so far exceeded what I expected, that if I subjoyned what I at first designed to add to it, it would prove a mis-shapen Book, and inconvenient to be open'd, wherefore it seemed expedient to divide the whole intended Work into two Volumes or Tomes, whereof what had already past the Press, should make the first, which that it might be the sooner serviceable should forthwith come abroad by it self, and the Second should consist partly of the other Papers abovementioned, as relating to the *Materia Medica*, and partly, of a Supplement to the first Tome, containing divers Historical Paralipomena, that by mistake were omitted, and are fit to be there supply'd out of a fuller Copy, then that which by an Oversight was made use of at the Press.

FINIS.







